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Edited by H. H. Brown, A. M. Inst. N. A.
Member Soc. N. A. and M. E.

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The Birth of a Permanent American Merchant Marine

WITH government expenditures for merchant shipbuilding, already made or proposed, amounting to nearly two billion dollars, the United States will soon have for seagoing service a brand new merchant marine of nearly eight million tons.

What additions to the present government plans for merchant shipbuilding may be made in the near future can only be surmised. If the war continues, the transportation of our troops and their equipment and supplies to Europe, to say nothing of the transportation of supplies for our Allies, will certainly require more ships. For the transportation and maintenance of each soldier sent overseas, something like four or five tons of shipping is required. If peace comes, the country will have in its possession not only a substantial seagoing merchant marine, for which there will be an urgent need for carrying material and equipment for the restoration of the devastated lands in Europe, but also a thoroughly established shipbuilding industry, the magnitude of which hitherto was undreamed of, involving the investment of vast sums of private capital and thousands of trained men.

The building of merchant ships, however, comprises only a part of the shipbuilding resources of the country. To the merchant fleet must be added the steadily increasing requirements for naval construction which have already absorbed a large percentage of existing shipbuilding facilities and transformed government navy yards into important shipbuilding establishments. To carry out the Navy Department's recent proposal for the construction of a large destroyer fleet, new shipyards must be built and extensive additions made to existing plants. If the war continues, the demands for naval construction will steadily increase. On the other hand, in the event of peace, a large part of the country's shipbuilding facilities now engaged in naval construction will undoubtedly soon become available for merchant shipbuilding, for the urgent need for huge naval armaments will cease to exist, even if some plan for gradual disarmament is not adopted by the nations of the world. With a return to normal conditions, a large part of the ordinary naval programme can, and probably will, be taken care of in the government plants which have been built up in the present crisis. This will mean, then, a large increase in the capacity of American shipyards available for merchant shipbuilding.

Whatever the immediate future may bring forth, therefore, as regards requirements for merchant or naval construction, the fact remains that the United States will have at its disposal resources for shipbuilding sufficient to place it in the front rank as a maritime nation. In addition to the shipbuilding resources, however, which involve enormous sums of invested capital, fully equipped shipbuilding plants, thousands of trained shipbuilders and correspondingly enlarged activities in industries allied to shipbuilding, there is still another factor which will tend to make the American merchant marine permanent.

Since the government started on its huge programme of merchant shipbuilding, steps have been taken to secure men to man these ships. In the face of an emergency, such as now confronts this country, the response from the ranks of seafaring men has been spontaneous. Induced by the opportunity of securing in the training schools established by the Shipping Board free training for positions as officers in the new merchant marine, hundreds of men who have hitherto had experience at sea are entering the government merchant marine service. Some forty thousand men in the United States hold licenses as either navigating or engineering officers in the merchant marine, many of whom have given up the sea and become established in various lines of business on shore. To these men the Service Bureau of the shipping Board is directing an appeal, urging their assistance by returning to their former work on board ship. Under the exceptional conditions now existing, many will undoubtedly take advantage of this opportunity, and by the time the new merchant fleet is finally in commission, the United States will have actively engaged on the high seas a force of experienced seamen, navigators and marine engineers more nearly commensurate with its importance as a maritime nation.

By providing these three prime requisites for a seagoing merchant marine—ships, shipbuilding facilities, and trained men to man the ships—the present emergency marks the birth of a permanent American merchant marine. All that has been accomplished in this time of danger cannot be overthrown in a moment. The foundation has been laid for a permanent place on the high seas for the American flag. It is now up to the American people, through their government in Washington, to maintain this place in friendly competition with the nations of the world.

Protection of Merchant Vessels in the War Zone

IN order to minimize the hazard to vessels trading to or from ports in Europe and on the Mediterranean coast of Africa, the government has established rules relative to the arming and visibility of all American vessels sailing to the war zone on and after October 1.

According to these rules, all vessels must be armed in accordance with the recommendation of the Navy Department, or if the Navy Department is unable to furnish such armament, the shipowners must furnish to the Bureau of War Risk Insurance satisfactory evidence that such armament has been applied for and cannot at the time be supplied. The Bureau will charge an additional

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rate of one percent on each voyage of vessels failing to comply with this requirement.

The regulations affecting visibility provide that each vessel shall be painted in accordance with one of the systems that are recommended by the chairman of the Naval Consulting Board and the Ship Protection Committee of the Emergency Fleet Corporation, as approved by the Bureau of War Risk Insurance. Information relative to the various methods of painting and how the painting can be arranged for, will be furnished upon application by the Bureau of War Risk Insurance, Treasury Department, Washington, D. C. Shipowners are free to select any one of the approved methods for their own use, and if they have a better method to offer it must be first submitted to and receive the approval of the chairman of the Naval Consulting Board, 11 Broadway, New York. Certificates from the party performing the work must be furnished to the Collector of Customs at the loading port, upon completion of the work.

Another rule affecting the visibility of a vessel provides that each steamer, at the time of sailing from the United States, must carry a sufficient supply of approved smokeless fuel to carry the vessel for not less than two daylight periods. This coal must be used during the daylight run while within the submarine zone. If the vessel is equipped with an improved system, whereby it can be operated without the emission of visible smoke from the stacks, it will not be required to comply with the above rule. All vessels operating through the submarine zone must also carry on deck one dozen approved smoke boxes, which will evolve smoke when thrown overboard.

Vessels must obtain from the Collector of Customs a certificate that all requirements affecting its visibility have been complied with. In the event of failure to obtain such a certificate, the Bureau will charge an additional premium of one-half percent for each voyage. The Bureau reserves the right to decline to insure vessels whose owners have not, in the opinion of the Bureau, made a satisfactory effort to comply with these requirements.

The above rules are in accordance with recommendations made by the Ship Protection Committee of the Emergency Fleet Corporation. Other recommendations were made at the same time, but have not yet been tested out sufficiently to warrant their being adopted. One of the most important of these is the recommendation made by William T. Donnelly, a member of the committee, providing that ships shall be equipped with buoyant means, so that the ship will be practically unsinkable, however seriously the hull may be damaged by torpedo or mine attack. One of the German ships taken over by the government at a Southern port is now being fitted out in accordance with this recommendation, and tests will soon be made to determine the desirability of equipping all vessels in such a manner. The method of carrying this out consists in fitting between the frames, along the sides of the vessel and against the bulkheads, watertight boxes or containers, the total buoyancy of which will be sufficient to keep the vessel afloat with the holds flooded.

Twin Screw Versus Single Screw Steamers for the Emergency Fleet

IN the Hough type of wooden steamship, described elsewhere in this issue, two distinct features are incorporated which have been patented by the designer. They are, first, the use of a central longitudinal bulkhead, extending throughout the length of the ship, in conjunction with twin hatches, and second, the peculiar construction of the bottom. By extending the centerline longitudinal bulkhead through the machinery space, a twin screw arrangement of the machinery becomes necessary. The adoption of the twin screw arrangement, however, is not solely on account of the longitudinal division of the engine room, but for other reasons which will become apparent after a little consideration.

In the first place, by using twin screws, the engines are much smaller and hence the parts of the engines, being comparatively small in comparison with similar parts of engines for a single screw ship of the same power, can be manufactured in the smaller machine shops throughout the country and a larger and more rapid production of the machinery can be assured. This is not the only advantage of the twin screw arrangement, however, for in the case of partial or total disablement of one engine the vessel can continue on her voyage without assistance.

In the case of the single screw vessel built of wood, if a propeller blade is lost, the vessel is at a disadvantage. Owing to the fact that the propeller with a blade missing is out of balance, the stern bearing in a wooden ship will soon work loose and destroy the watertight sleeve and then flooding may result. To avoid this it is necessary either to run the engine dead slow or to stop. Numerous instances are on record on the Pacific coast of single screw wooden steamships which, after losing a propeller blade and limping into port, have been ordered towed to the nearest port having a dry dock, in order to avoid running the main engines.

Another advantage of the twin screw arrangement is the fact that the vessel can be handled more smartly in maneuvering than a vessel with a single screw. As the speed of the vessels built for the emergency fleet does not exceed that of the submarine, a quick change of course or a zigzag course with quick turns may be of inestimable value while the vessel is in the submarine zone.

Other features of the Hough design will undoubtedly prove of value in the present emergency, but it should be understood that the vessel is not an emergency ship in the sense that it is a hastily built ship good only for a few voyages at sea. The design is thoroughly substantial and seaworthy and was evolved before the present need of an emergency fleet developed. It has been successfully used in the construction of several seagoing steamships on the Pacific coast, entirely apart from the government emergency fleet.

Encouragement for Inland Water Transportation Advocates

THOSE who have in the past been inclined to the view that railroads would, by all means in their power, discourage the use of water facilities by making low competitive rates and through refusal to participate in joint rates and through billing arrangements, declining to build tracks, docks, etc., will be reassured by the attitude of the Chicago, Burlington & Quincy Railroad, as expressed in a recent letter from C. G. Burnham, vice-president of the road, to the Secretary of Commerce. Mr. Burnham states emphatically that it is the earnest desire of the management of the Chicago, Burlington & Quincy Railroad that every opportunity be taken to assist in the development of the practical use of inland waterways. If other railroads, which are in a position to cooperate with steamboat lines, would join this road in their efforts to promote the development of inland waterway transportation, practical results would soon be forthcoming, which, with the present burden placed on traffic, would without question be of great benefit to the country.

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LETTERS TO THE EDITOR

Statement Regarding Lord Pirrie's Connection with Motorship Industry Corrected

In your May issue, I find an article written by Mr. T. O. Lisle about "Lloyd George's Speech and Its Relation to Motorship Development." This article, of course, has been read with great interest by all the Burmeister & Wain people, and I only take the liberty to send you these lines in order to correct a few remarks which do not quite agree with the real facts.

At the bottom of page 205 it is mentioned:

"One of the great shipping interests controlled by him (Lord Pirrie) has sold all its steamers and replaced them with Diesel motorships."

We suppose this to be an error, as it is the East Asiatic Company of Copenhagen, which is not controlled by Lord Pirrie, which has sold all its steamers and is now exclusively using Diesel motorships.

Further it is said:

"Furthermore, it is through Lord Pirrie interests that a small European steamship building yard has become one of the most important mercantile motor shipyards in the world. This yard now has its capacity booked for six years ahead entirely with Diesel motorships. No steamship yard in the world is in such a fortunate position."

The concern in question is A. S. Burmeister & Wain's Maskin- og Skibsbyggeri (Burmeister & Wain's Engine & Shipbuilding Company), Copenhagen, Denmark, and only some time after Burmeister & Wain had started motorship building was Lord Pirrie's name connected with this branch of the industry, as he became interested in an activity in Glasgow, viz., The Burmeister & Wain (Diesel System) Oil Engine Company, Ltd. The person who, by ordering Diesel motorships, has caused the rise of our firm to the brilliant position it now possesses, with regard to the Diesel motorship building, is the managing director of the East Asiatic Company of our city, Counsellor of State Mr. Andersen.

For the sake of accuracy, we would point out that our yard has its capacity fully booked for *eight years ahead* (not for six years) with Diesel motorships. Finally, we may add that the exclusive rights for building Burmeister & Wain marine Diesel engines in America have recently been taken over by The William Cramp & Sons Ship & Engine Building Company, Philadelphia, Pa., and we hope that within a short time this firm will have the same success with Diesel engined vessels as we have had.

IVAR KNUDSEN,
Chief Engineer, Burmeister & Wain's Engine & Shipbuilding Company.
Copenhagen, Denmark.

Future of the American Merchant Marine

Mr. N. L. Snow's communication, published in the August issue of MARINE ENGINEERING, wherein he pointed out the probable future need for a subsidy, if our vessels are to compete with those operated by other nations when shipping conditions return to normal, was interesting and expressed the consensus of opinion among shipping authorities.

In taking issue with the optimism relative to future shipbuilding evinced by me in an earlier number he has, I am inclined to believe, misunderstood the thought. His statement that "the capitalists who are putting their money into shipyards and export companies might show some concerted opinion, indicating that they expect the Government and the people of the United States to pass a subsidy act which will insure the investments and provide the country with a merchant marine," is synonymous with my former statement that "We cannot build up such a tremendous structure for immediate profit and overthrow it at will."

With respect to the subsidy there is room for considerable diversity of opinion. Certain it is that our freight vessels will be much more numerous and the crews at hand to man them when normal trade is resumed. This, however, will not be directly subsequent to cessation of hostilities, nor for possibly two or three years following that much to be desired event.

The situation in Europe will simulate that immediately after our Civil War, when rehabilitation played possibly as large a part as steel ships in discouraging our merchant service. There is obvious need for merchant ships under our flag, and they will no doubt be demanded by our people, for the shipping question never before gripped the entire populace as it does to-day.

To attempt planning an equitable subsidy under present conditions would be folly, for there is no means of realizing the nature it should take nor the degree to which it should apply. Subsidy under existing conditions is unnecessary. That it will be an adjunct in the future is highly probable, but what man can devise a plan which will prove most feasible in those future times? Let us look to the subsidy when needed, but not until then.

The encouragement afforded by the Shipping Board, and heretofore rather questionable, but which will take more concrete form very shortly, is subsidy in a sense. That the Government has appointed that board is sufficient to vouch for public interest in shipping. That the blunders and politics attending its inauguration will not endure has already begun to be evinced.

We can build and operate ships at a profit, just as we have extended our other industries to the far corners of the earth. It is a question of capital, sustained public interests and efficient administration which will decide our future shipping status. ARTHUR F. JOHNSON.

Washington, D. C.

A Clipper Ship of 1853

In view of the present revival in wooden shipbuilding in the United States, the following particulars of an old-timer, seen by Sir Joseph Whitworth on the stocks in 1853, may be of interest. The particulars are taken from the collected papers of this famous engineer, and are contained in his report on the New York Industrial Exhibition.

"A Four-masted Clipper Ship. A large clipper ship of 4,000 tons was being built at Boston; the length of the keel was 287 feet, length on deck 320 feet, extreme breadth of beam 52 feet, and depth of hold 30 feet. Her keel is of rock maple in two thicknesses, the frame is of seasoned white oak, doweled, and bolted together through the doweling with 1¼-inch iron. The frame inside is diagonally cross-braced with iron, the braces being 4 inches wide, and ¾-inch thick, bolted through every timber; these braces extend from the floor heads to the top timbers, and form a perfect network of iron over all her frames, fore and aft.

"She has five depths of midship keelsons, each 16 inches square, bolted vertically and horizontally. There are four tiers of bilge keelsons on each side 15 inches square.

(*Concluded on page* 408.)

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Hough Type Wooden Steamship

Designed by Edward S. Hough, Consulting Engineer, San Francisco, Cal., for the United States Shipping Board Emergency Fleet Corporation

SEVERAL of the wooden steamships which are to be built for the emergency fleet of the United States Shipping Board will be constructed according to designs developed by Edward S. Hough, naval architect and consulting engineer, San Francisco, Cal. This type of vessel has been designed with the special object of securing rapid construction and minimum cost, and for this reason it involves a number of radical departures from ordinary wooden ship construction.

The vessel is of the 'tween deck type, schooner rigged, with two pole masts fitted with cargo booms, and is of the following dimensions:

Length over all	286 feet
Length between perpendiculars	276 feet
Beam, molded	45 feet
Beam over planking	46 feet
Depth, molded to upper deck	28 feet
Dead rise	3 feet
Deadweight capacity	3,500 tons
Total horsepower	1,400
Sea speed, loaded	10½ knots

As can be seen from the general plans, the Hough type of vessel is thoroughly adapted for emergency construction in that ordinary ship curves have been eliminated as

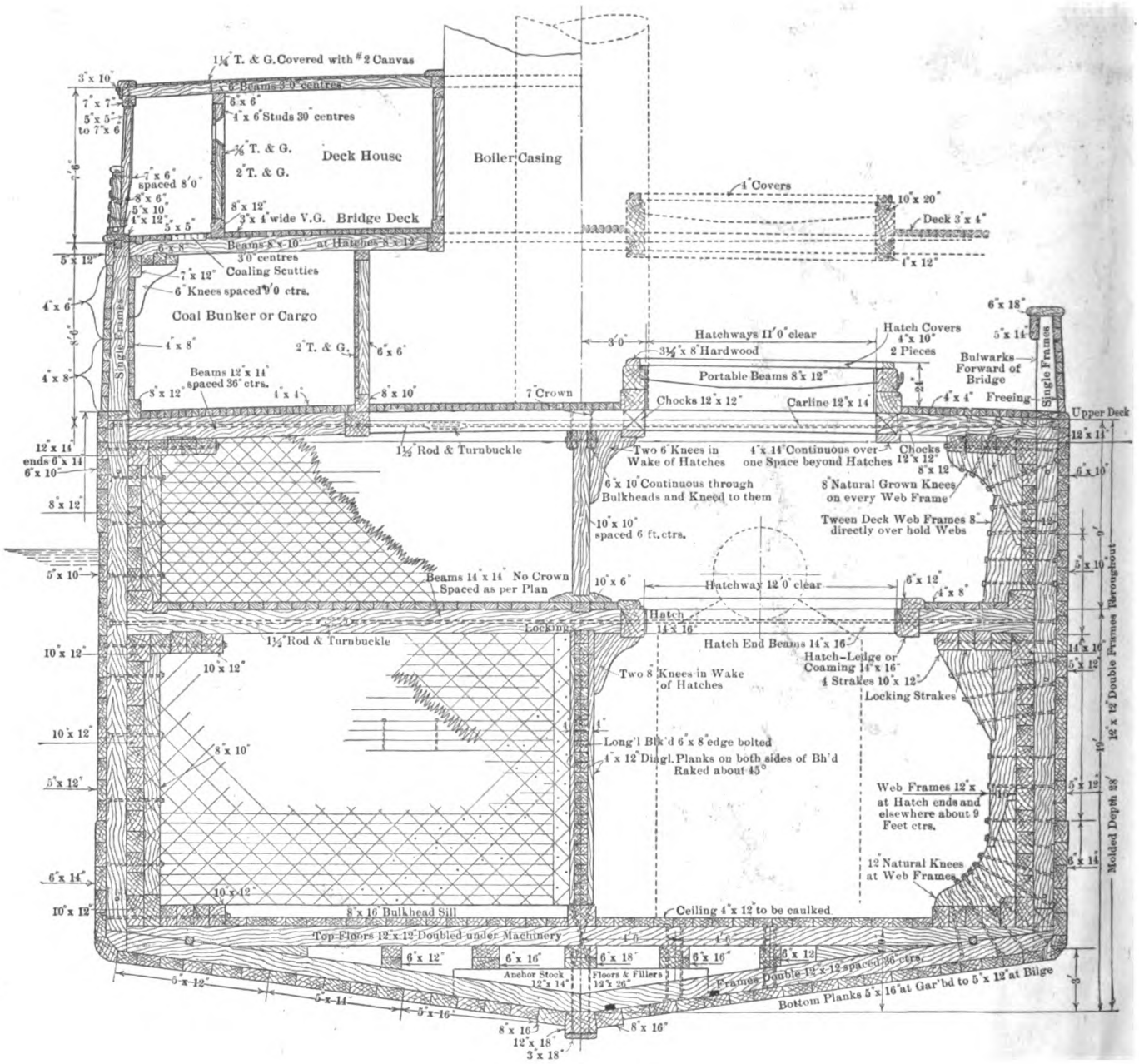
1¼" T. & G. Covered with #2 Canvas
6" Beams 3'0" centres
8"x 6"
4"x 6" Studs 30" centres
Deck House
Boiler Casing
2" T. & G.
8"x 12"
3"x 4" wide V.G. Bridge Deck
Beams 8"x 10" at Hatches 3'0" centres
7"x 12"
Coaling Scuttles
6" Knees spaced 3'0 ctrs.
Coal Bunker or Cargo
Single Frames
Beams 12"x 14" spaced 36" ctrs.
7" Crown
1½" Rod & Turnbuckle
4" Covers
10"x 20"
Deck 3" x 4"
Hatchways 11'0" clear
Hatch Covers 4"x 10" 2 Pieces
3½"x 8" Hardwood
Portable Beams 8"x 12"
Chocks 12"x 12"
Carline 12"x 14"
Bulwarks Forward of Bridge
4"x 4" Freeing
Upper Deck
Two 6" Knees in Wake of Hatches
4"x 14" Continuous over one Space beyond Hatches
6"x 10" Continuous through Bulkheads and Kneed to them
8" Natural Grown Knees on every Web Frame
Tween Deck Web Frames 8" directly over hold Webs
10"x 10" spaced 6 ft. ctrs.
Beams 14"x 14" No Crown Spaced as per Plan
Hatchway 12'0" clear
Hatch 14"x 16"
Locking
Hatch End Beams 14"x 16"
Hatch-Ledge or Coaming 14"x 16"
4 Strakes 10"x 12"
Locking Strakes
Two 8" Knees in Wake of Hatches
Long'l Bk'd 6"x 8" edge bolted
4"x 12" Diag'l. Planks on both sides of Bh'd Raked about 45°
Web Frames 12"x at Hatch ends and elsewhere about 9 Feet ctrs.
12" Natural Knees at Web Frames
Molded Depth 28'
12"x 12" Double Frames Throughout
8"x 16" Bulkhead Sill
Ceiling 4"x 12" to be caulked
Top Floors 12"x 12" Doubled under Machinery
Anchor Stock 12"x 14"
Floors & Fillers 12"x 26"
Frames Double 12"x 12" spaced 36" ctrs.
Bottom Planks 5"x 16" at Gar'bd to 5"x 12" at Bilge

Fig. 1.—Midship Section

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much as possible and straight-line work has been substituted. For the greater part of the length of the vessel the sides are flat and the bottom V-shaped, with a deadrise of 3 feet. With this form of hull the majority of the frames are straight 12-inch by 12-inch timbers—a common stock size of timber, generally known as "mill run" lumber. As the sides and bottom are straight for the greater part of the length, most of the planking and ceiling is also straight-line work, and can be gotten out in a minimum of time and with a minimum of hand labor.

As the Hough design closely resembles that of a barge, the building of the ship will require very much less shaping and molding than is the case with the usual ship model. Not only are the timbers and planking for the most part straight, and therefore can be quickly and accurately cut at the mills, but also the fastenings and connections are such that time will be saved in checking and fitting the planks and timbers as compared with the ordinary ship form of vessel. An important advantage of the design is the fact that very little frame or surface dubbing will be required, and with the straight-sided machine-cut planking the calking can be more easily and quickly performed.

A raised forecastle deck and a house aft provide gun platforms, on which will be mounted rapid-fire guns for defense against submarine attack. Amidships is a bridge deck, above which is a boat deck, and in the midship deck houses all hands will be quartered.

General Arrangement

Propulsion is by two sets of triple-expansion reciprocating engines, supplied with steam by two boilers operating under forced draft. Geared turbine propelling machinery can be substituted for the reciprocating engines at the option of the builder.

The hull is subdivided by six transverse bulkheads in the 'tween deck space and five transverse bulkheads below the main deck. A double bottom extends from the forward collision bulkhead to the inboard end of the stern tube, and this is subdivided at the transverse bulkheads, as shown in the general plans. These spaces are used for water ballast and are piped for filling and emptying as usual.

A longitudinal centerline bulkhead extends the full length of the ship from the forward to the after collision bulkheads and up to the main deck. This bulkhead is built up of 6-inch by 8-inch edge-bolted material, faced on both sides with 4-inch by 12-inch planking worked diagonally and landing against a continuous sill at the top and bottom. This bulkhead is not calked and openings are provided as shown on the plans.

Cargo is handled through three sets of twin hatches by means of six cargo booms of 5 tons capacity each, fitted to the masts and served by steam winches.

Fresh water is carried in steel tanks stowed about the machinery spaces and at the stern of the ship. Provision is made for 80 tons of fresh water for boiler use and 30 tons for culinary purposes.

The vessel is thoroughly equipped with auxiliary machinery, including an electric light plant, steam winches, steam capstan, steam windlass, steam-steering gear with hand auxiliary, an ice machine, a steam-heating system and a pumping and drainage system.

Keel and Keelsons

The keel consists of a timber, 12 inches by 18 inches, in long lengths fastened with 1¼-inch headed bolts set up over clinch rings at the bottom. The keel is fastened to the center keelson and to the top floor timbers as follows: In each bay one 1⅛-inch drift bolt driven from the inside and clinched over a ring outside; in each bay two 1¼-inch headed bolts driven from the inside and clinched over rings on the bottom of the keel; at each frame two 1⅛-inch drift bolts are driven from the inside and clinched over rings outside.

The keel is protected by a shoe 3 inches thick by 18 inches wide.

Stem and Stern Post

The stem, sided 18 inches and molded 24 inches, is 46 feet long and scarfed to a natural knee at the forefoot. A half round iron band, 5 inches wide, extends from the stem head down to 2 feet below the light waterline, and is wrapped over and fastened to a ¾-inch by 10-inch flat band extending around the forefoot over the keel split and spread at the end. The apron, sided 18 inches and molded 24 inches, is in one length, extending to the forecastle deck. The knightheads are in one length to the forecastle head, sided 24 inches and molded 12 inches. A natural knee connects the stem to the keel and the deadwoods are chocked into the keelson and apron.

The stern post is 48 inches fore-and-aft and 18 inches wide, bearded aft near the rudder to 12 inches wide. The bottom is fitted with a cast-steel shoe, carrying the bottom rudder pintle and the top is chocked solid at the deck beams and kneed off sideways. A rudder trunk is built on the after side of the post, fitted with a round lead sleeve turned over and made tight top and bottom. A cast-steel bearing ligned with lignum vitæ is placed at the bottom of the sleeve and a cast-iron stuffing box at the top. The after deadwoods are worked diagonally, as shown in the plans, a natural knee being fitted at the junction of the keel and stern post. Two horn timbers, 18 inches by 20 inches and about 24 feet long, are placed one on each side of the stern post connecting with the rim and landed on the frames.

The rudder is built up of two ½-inch steel plates set apart 24 inches, stiffened by horizontal web plates and angles. The rudder stock is of forged steel.

Framing

The side frames are double, 12 inches by 12 inches, spaced 36 inches centers throughout and extending from the bilge to the upper deck. In the way of the bridge house they are single, one leg of the frame being in one length from the bilge to the upper deck, the lower end of the leg butting and the other lapping the transverse floor timbers.

Cant frames, of the same siding and molding as the main frames, are built up at the ends of the vessel and well fitted to the deadwood.

The bottom floor timbers are double, 12 inches by 12 inches butted, as shown on the drawings and secured by an anchor stock piece the same width as the frame. The top timbers are single, except under the machinery, and are 12 inches by 12 inches in one length.

The bottom timbers and heels of the frame are fastened together by two 1-inch screw bolts, each with plate washers under the head and nut. At the heels of the frames the bays are chocked and made watertight with a stop-water at each side of the chock, shutting off the bottom from the side spaces. Each anchor stock piece is fastened to a bottom floor timber by two 1⅛-inch screw bolts each side of the center.

Under the machinery the top floor timbers are doubled and the spaces between the top and bottom floor timbers are chocked in solid.

The side ceiling is 10 inches by 12 inches, the three up

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and bottom strakes being scarfed 7 feet. The bilge ceiling consists of four strakes 10 inches by 12 inches and one strake built up of two pieces 10 inches by 18 inches with 8-foot laps. All four strakes are edge-bolted and fastened to the floors. The first two strakes are edge-bolted to the bilge log.

PLANKING

The garboard strake is 8 inches by 16 inches edge-bolted to the keel, with 7/8-inch iron in alternate frame spaces. It is fastened to every frame with four 1-inch by 20-inch buttonhead bolts with the heads countersunk and cemented.

The bottom and side planking is 5 inches thick, varying from 16 inches in width at the garboard to 12 inches at the bilge and from 12 inches to 10 inches at the sides. Several strakes of 6-inch planking are provided at the bilge and wales, as shown on the midship section.

IRON STRAPPINGS

In addition to the longitudinal and transverse bulkheads and double bottom, the hull is further strengthened by iron strappings which extend from well forward of No. 1 hatch to abaft of No. 3 hatch. Diagonal iron straps, 1/2 inch by 4 inches, are let into the outside of the frames and inclined at 45 degrees each way. These are fitted so as to meet at the top butt in every other frame space.

The diagonals are connected at the top butt by two 7/8-inch rivets and at each crossing by one 1-inch fitted bolt. They are also fastened to each frame timber by a 1-inch by 10-inch counter-sunk head blunt bolt. The bottom is securely fastened at the bilge corner.

DECKS

At the main and upper decks are clamps and shelves built up as follows: The clamp at the main deck is 14 inches by 16 inches, the shelf consisting of four strakes each 10 inches by 12 inches; two strakes being locked 2 inches into the beams. The upper deck clamp is 12 inches by 14 inches, while the shelf strakes, of which there are four, are 8 inches by 12 inches.

The upper deck beams are 12 inches by 14 inches, spaced about 36 inches centers and have a 7-inch camber. They are doubled at the hatch ends and boiler openings. Half beams are landed on a fore-and-aft sill, 4 inches by 14 inches, and pulled up to the deck coamings by screw bolts.

The main deck beams are 14 inches by 14 inches, spaced about 48 inches centers doubled at the hatch ends. The main deck ('tween deck) is laid solid with 4-inch by 8-inch planking and calked.

TIE RODS

Tie rods, 1 1/2 inches diameter, are fitted from the sides of the vessel to the hatch sills at the upper and main decks. Two are provided in way of each hatch. At the hatch end and at every fourth beam between hatches the tie rods extend clear across the vessel and are fitted with turnbuckles.

WEB FRAMES

Web frames are built in at the hatch ends and elsewhere spaced about 9 feet centers. They consist of vertical pieces butting against the knee at the bilge corner and the upper deck and are fastened together so as to make solid work.

Two of the distinctive features of this vessel, the central longitudinal bulkhead in conjunction with twin hatches and the construction of the bottom, have been patented by the designer.

Salvage of Floating Dry Dock Driven High and Dry on River Bank in Storm

BY G. J. DELACROIX

DURING the hurricane of July 5, 1916, a floating dry dock, in which the steam tug *Gulfport* was undergoing repairs, was blown from its moorings at the plant of the Ollinger & Bruce Dry Dock Company, Mobile, Ala., and drifted about two miles up the Mobile river, finally being driven high and dry on the west bank of the river, as shown in Fig. 2. The dock was in three sections and the tug rested on the keel and bilge blocks of the two after sections, the bow of the tug extending on to the third or forward section.

Difficulties were encountered in salvaging the dock, because of the fact that many barges and other floating property had been jammed on the bank of the river in

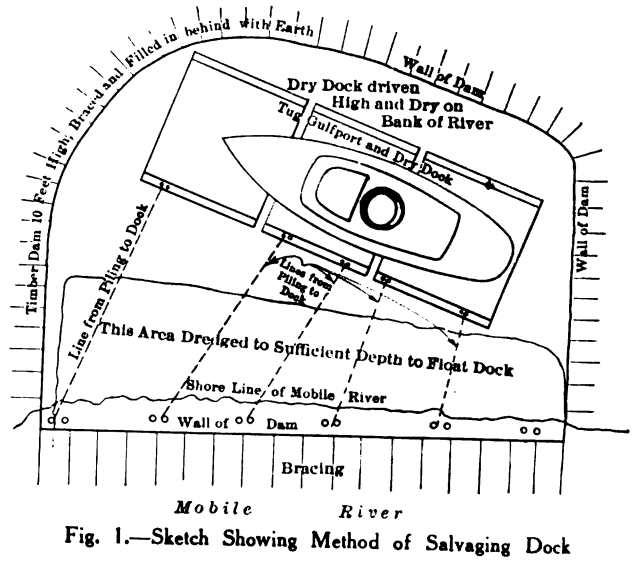
Filled in behind with Earth
Wall of Dam
Dry Dock driven High and Dry on Bank of River
Tug Gulfport and Dry Dock
Timber Dam 10 Feet High, Braced and
Line from Piling to Dock
Line from Piling to Dock
This Area Dredged to Sufficient Depth to Float Dock
Shore Line of Mobile River
Wall of Dam
Bracing
Mobile River

Fig. 1.—Sketch Showing Method of Salvaging Dock

front of the dock. The work was undertaken by the Jett-Muth's Construction Company, Inc., and successfully accomplished within a comparatively short time. The method of salvaging the dock is indicated in the diagram, Fig. 1. A channel was dredged parallel to the river, and as close to the dock as was practical. Then six clusters of piling, each cluster consisting of two piles, were driven along the shore line of the river, as indicated in the sketch, and lines were run from the clusters of piling to the dock, which were to be used for hauling the dock into the channel. A timber dam, 10 feet high, was then built, surrounding the dock, the dredged channel and piling. The dam was braced from without with timbers and then filled in with earth to add strength.

Water was pumped into the inclosure formed by the dam until the dock was afloat, then the lines from the piling were set up taut and the dock hauled alongside the piling. After this, holes were cut in the dam and the water in the inclosure allowed to recede to the level of the river, the dock floating in the dredged channel. The dam was then torn away and the dock, still holding the tug, was safely towed back to the plant of the Ollinger & Bruce Dry Dock Company.

During all these operations the tug *Gulfport* was not displaced from its keel and bilge blocks in the dock until after the dock had been floated back to the repair plant and repairs had been finished on the tug.

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SALVAGE OF STRANDED DRY DOCK AND TUG AT MOBILE

Work Carried Out by Jett-Muth's Construction Company, Inc.

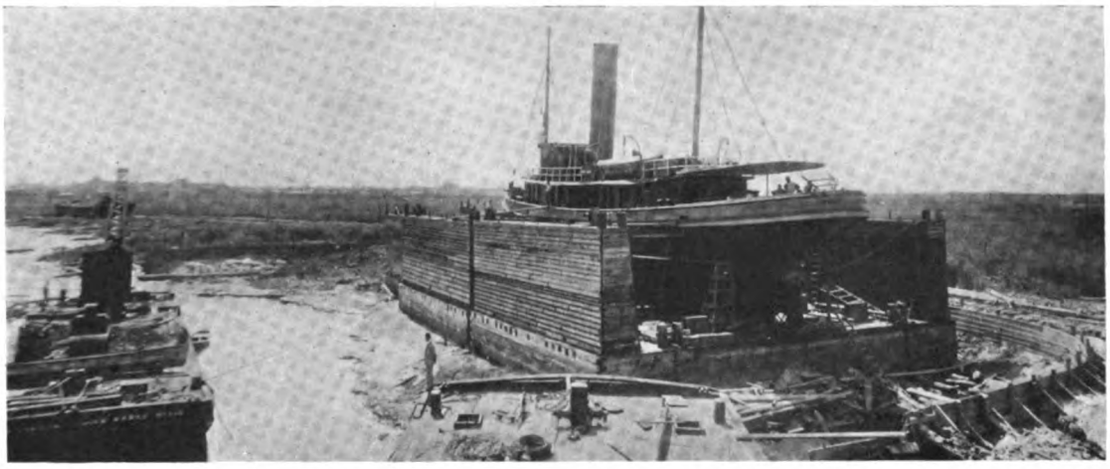

Fig. 2.—Dredging a Channel Alongside Stranded Dock

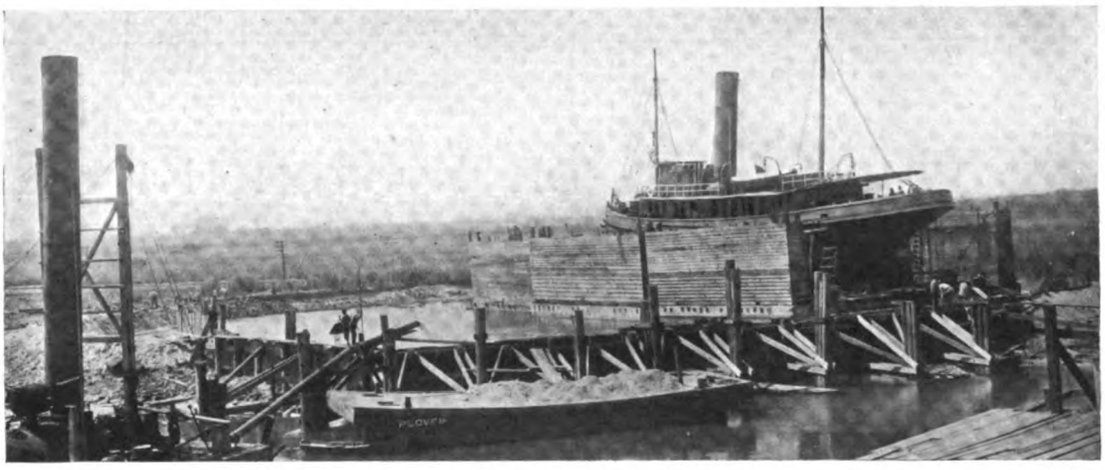

Fig. 3.—Timber Dam, Enclosing Dock and Dredged Channel

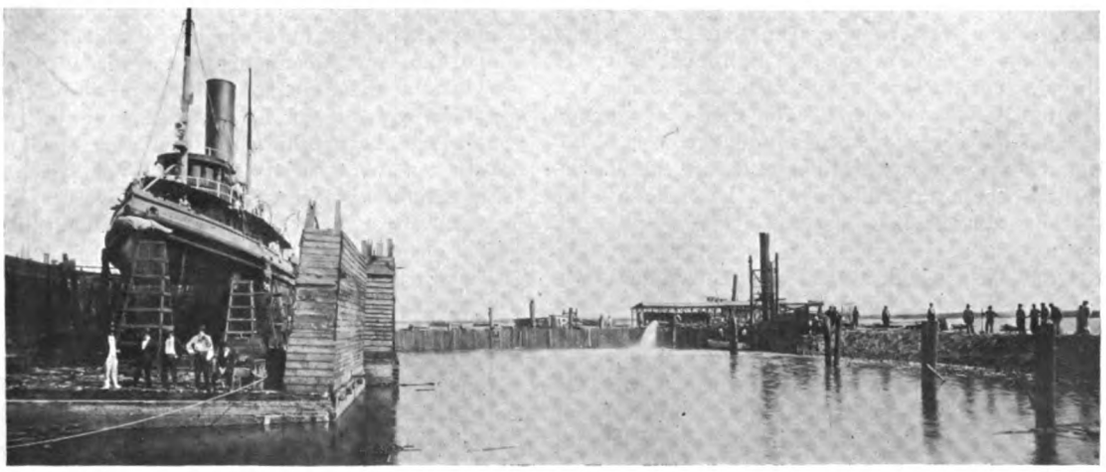

Fig. 4.—Inclosure Filled with Water and Dock Floated into Dredged Channel

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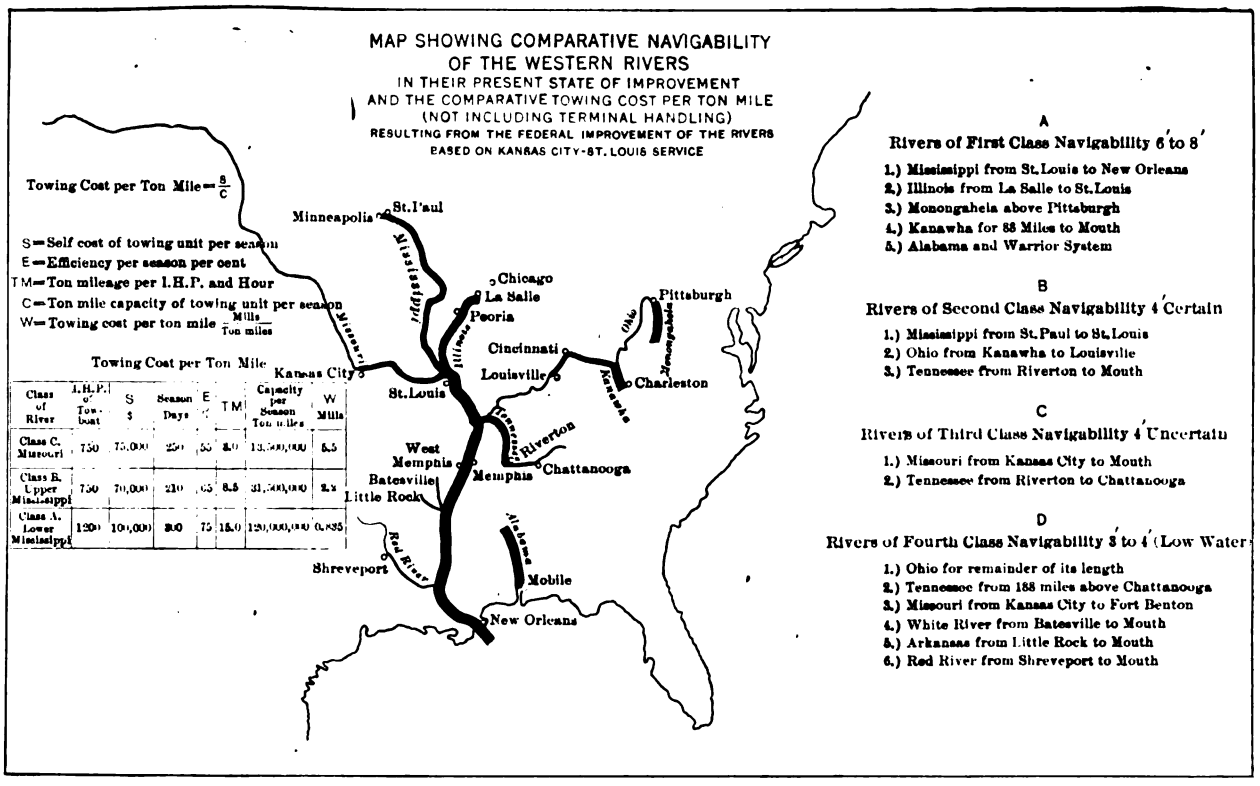
MAP SHOWING COMPARATIVE NAVIGABILITY
OF THE WESTERN RIVERS
IN THEIR PRESENT STATE OF IMPROVEMENT
AND THE COMPARATIVE TOWING COST PER TON MILE
(NOT INCLUDING TERMINAL HANDLING)
RESULTING FROM THE FEDERAL IMPROVEMENT OF THE RIVERS
BASED ON KANSAS CITY-ST. LOUIS SERVICE
Towing Cost per Ton Mile = S/C
S = Self cost of towing unit per season
E = Efficiency per season per cent
TM = Ton mileage per I.H.P. and Hour
C = Ton mile capacity of towing unit per season
W = Towing cost per ton mile = Mills/Ton miles
Towing Cost per Ton Mile
Class of River | I.H.P. of Towboat | S $ | Season Days | E % | TM | Capacity per Season Ton miles | W Mills
Class C. Missouri | 750 | 75,000 | 250 | 55 | 8.0 | 13,500,000 | 5.5
Class B. Upper Mississippi | 750 | 70,000 | 210 | 65 | 8.5 | 31,500,000 | 2.2
Class A. Lower Mississippi | 1200 | 100,000 | 300 | 75 | 15.0 | 120,000,000 | 0.835
Minneapolis
St. Paul
Chicago
La Salle
Peoria
Cincinnati
Louisville
Kansas City
St. Louis
Pittsburgh
Charleston
West Memphis
Batesville
Little Rock
Memphis
Chattanooga
Shreveport
Mobile
New Orleans
Mississippi
Missouri
Illinois
Ohio
Monongahela
Kanawha
Tennessee
Riverton
Red River
Alabama
A
Rivers of First Class Navigability 6 to 8'
1.) Mississippi from St. Louis to New Orleans
2.) Illinois from La Salle to St. Louis
3.) Monongahela above Pittsburgh
4.) Kanawha for 88 Miles to Mouth
5.) Alabama and Warrior System
B
Rivers of Second Class Navigability 4' Certain
1.) Mississippi from St. Paul to St. Louis
2.) Ohio from Kanawha to Louisville
3.) Tennessee from Riverton to Mouth
C
Rivers of Third Class Navigability 4' Uncertain
1.) Missouri from Kansas City to Mouth
2.) Tennessee from Riverton to Chattanooga
D
Rivers of Fourth Class Navigability 3 to 4' (Low Water)
1.) Ohio for remainder of its length
2.) Tennessee from 188 miles above Chattanooga
3.) Missouri from Kansas City to Fort Benton
4.) White River from Batesville to Mouth
5.) Arkansas from Little Rock to Mouth
6.) Red River from Shreveport to Mouth

Fig. 1.—Map Showing Comparative Navigability of Western Rivers

Towing Costs on Western Rivers

Investigation of Factors Which Influence Cost of Towing—Towing Equipment and Formation of Tows—Cost Data

By M. von Pagenhardt *

THE towing cost is obviously a function principally of the depth of channel and the current velocity, but we shall endeavor in the following article to determine their correct influence together with the secondary influence of wages, fuel, repairs and fixed charges, which make Western river towing such a peculiar problem.

The accompanying map (Fig. 1) shows the comparative navigability of the Western rivers in their present state of improvement. They are divided into four classes of navigability, no distinction being made between slack water of 6-foot depth and swift water of 8-foot channel depth, as, economically, they seem to balance.

In this first class, which we call class *A*, are the Mississippi below St. Louis, the Illinois below La Salle and the Monongahela, Kanawha and Alabama as far as provided with locks and dams.

In the second class, which we call class *B*, are the rivers with an assured 4-foot channel and a current velocity of less than 2.5 miles per hour, such as the upper Mississippi, the lower Tennessee and stretches of the Ohio.

In the third class, which we call class *C*, are the rivers with a shifting 4-foot channel and a current velocity of 3 miles and more, such as the Missouri below Kansas City and stretches of the Tennessee above Riverton.

In the fourth class are the rivers with an assured channel of 3 to 4 feet, with more or less current velocity, such as the Red, Arkansas, White, the Missouri above Kansas City, the upper Tennessee, stretches of the Ohio in low water, and many others.

This last class is not adapted to Western River towing, as the cost per ton-mile is in excess of the revenue per ton-mile fixed by competing rail rates. Only a combined passenger and freight service can financially succeed. We shall not deal here with this problem.

Towing service is analogous to railroad through-freight service. It must compete with railroad rates established between water points. It must maintain a differential water rate below this already lowered rail rate and it must, as a rule, absorb heavy terminal switching charges. This cannot be accomplished in individual small efforts, but only by a properly dimensioned undertaking.

The operating cost of a towing service with towboats of equal power is practically the same all over the Western rivers, while the revenue depends on the amount of tonnage which can be transported up- and down-stream in a practical tow formation in the respective channels in a given time. The balance can only be drawn after the completion of an average round trip or at the end of a season.

Capacity and Efficiency of a Towboat

The towing capacity of a towboat is practically the same down-stream as up-stream. One is led to believe that a towboat can take more pieces down than up, but in

* Naval architect, Kansas City, Mo.

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reality this greater down-stream haul is without financial advantage, as corresponding time is lost in the round-trip movement, for the towing capacity is a product of tonnage and mileage and this product is practically constant for a given class of river.

The tonnage moved by a 750 horsepower Mississippi towboat might be 3,000 tons and the speed up-stream 3.5 miles per hour and down-stream 9 miles per hour. The average speed during the round trip is then:

$$\frac{2 \times 9}{1 + \frac{9}{3.5}} = \frac{18}{3.57} = 5$$

miles per hour (approximately) and the average ton-mile capacity is 15,000 ton-miles per hour. This product is constant. If more pieces are hooked onto the tow with additional tonnage, the speed will be decreased proportionately and the capacity will remain 15,000 ton-miles per hour.

Also, the towing capacity of a towboat must be a function of the horsepower or the pushing power of the towboat; it must vary with the channel depth and the channel width; it must vary with the current velocity; it must finally depend on the percentage of operating efficiency which can be attained in the particular class of river; by this, we mean the ratio of total hours of service and the actual running hours, which varies from 50 to 75 percent.

Capacity Miles

By observation, we find the following facts to govern towing service in the three classes of rivers:

(1) Rivers of Class *A*.—A towboat can push 4 tons per horsepower and maintain the required speed of 5 miles per hour or develop a ton-mileage of 20 ton-miles per hour per horsepower. The operating efficiency should be 75 percent. The average capacity is, therefore, 15 ton-miles per hour per horsepower per season.

Example.—A 750-horsepower towboat operating in the lower Mississippi has a daily capacity of 270,000 ton-miles, and in a season of 300 days a capacity of 80,000,000 ton-miles. A 500-horsepower towboat operating in the Monongahela has a daily capacity of 180,000 ton-miles, and in a season of 300 days a capacity of 54,000,000 ton-miles. The towboats in actual service transport coal down-stream only and have no return freight. Their ton-mile capacity should be, therefore, better than 27,000,000 ton-miles per season, as they gain time going light up-stream. Their actual ton-miles capacity is stated as 30,000,000 ton-miles per towboat per season and 100,000 ton-miles per day.

(2) Rivers, Class *B*.—A towboat can push 2 tons per horsepower and maintain a speed of 6.5 miles per hour, or can push 2.6 tons per horsepower and maintain a speed of 5 miles per hour. The capacity is 13 ton-miles per horsepower per hour and an operating efficiency of 60 to 65 percent can be maintained. The average capacity is, therefore, 8.5 ton-miles per horsepower per hour per season.

Example.—A 750 horsepower towboat operating between St. Paul and St. Louis can transport 1,500 tons per trip and maintains a daily capacity of 150,000 ton-miles, or reach in a seven-month season a capacity of 31,500,000 ton-miles.

(3) Rivers, Class *C*.—A towboat of 750 horsepower can push 1 ton per horsepower and maintain a speed of 6 miles per hour, or 1.2 tons per horsepower, and maintain a speed of 5 miles per hour. Her capacity is 6 ton-miles per horsepower per hour. An operating efficiency of 50 to 55 percent can be maintained. The average capacity is, therefore, 3 ton-miles per horsepower per hour per season.

Example.—A 750 horsepower towboat operating on the Missouri between Kansas City and St. Louis can maintain a daily capacity of 54,000 ton-miles and in a season of 240 days a capacity of 13,000,000 ton-miles.

Daily Capacity a Predeterminable Amount

The capacity of a 750 horsepower towboat is, therefore, a predeterminable amount, varying from 54,000 ton-miles per day in class *C* rivers to 150,000 ton-miles in class *B* rivers to 270,000 ton-miles in class *A* rivers, or varying in the ratio of 1 to 2.8 to 5.0.

Determination of the Towing Unit (See Fig. 2)

The towing unit is the combination of towboats and barges, with barges for exchange and reserve, with lighters for shallower rivers, and its percentage of harbor tugs, repair yards and other equipment. The towing unit represents a value of $250,000 (£51,300) in any class of river. Equipment for class *C* consists of the same number of pieces practically as equipment for class *A*, and is only less deeply loaded. Equipment for class *A* rivers must

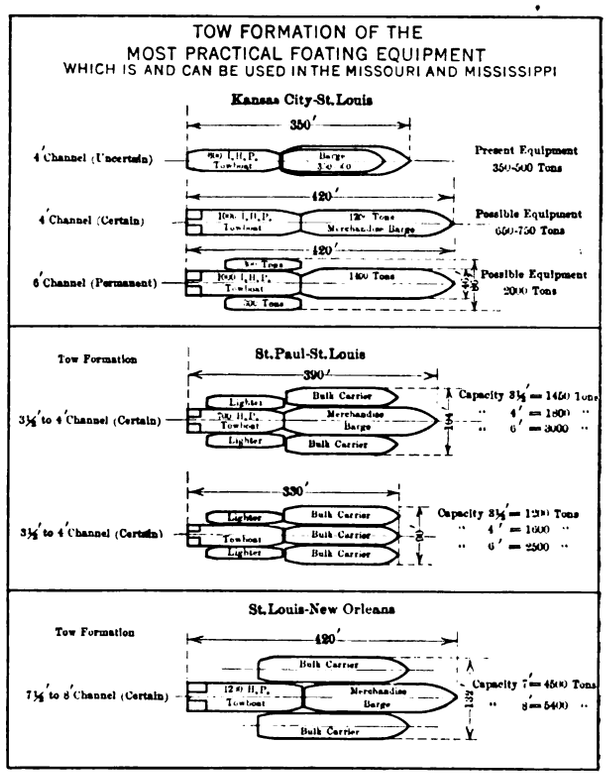

Fig. 2

have capacity for a tonnage equal to 4 or 5 times the horsepower; equipment for class *B* 2 to 2.5 times the horsepower; equipment for class *C* rivers 1 to 1.5 times the horsepower.

In reality a combination between barges and lighters is desirable. The lower Mississippi towing unit consists preferably of three large barges drawing 8 feet. The canalized river towing unit consists preferably of two large and one small barge drawing 6 to 7 feet. The upper Mississippi towing unit consists preferably of one large barge, two small barges and two small lighters spreading out, as it were, in the slack current of the 4-foot channels. The swifter Missouri, however, calls in its best equip-

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ment for a single large barge and only possibly two lighters which can be double tripped through narrow places of excessive swiftness. All merchandise barges should be designed with a view of the future deeper channel of possibly even 9-foot depth; they should be readily exchangeable and their lines should be in accordance with a design of least resistance.

The number of towing units is determined by the distance between terminal points, which varies from 50 to 2,000 miles. A single unit is commercially possible in a short trade of 50 to 250 miles, but, as a rule, one unit is required for each 100 to 125 miles of river, so as to maintain a service of not exceeding two to three days' interval. A towing service between St. Louis and New Orleans,

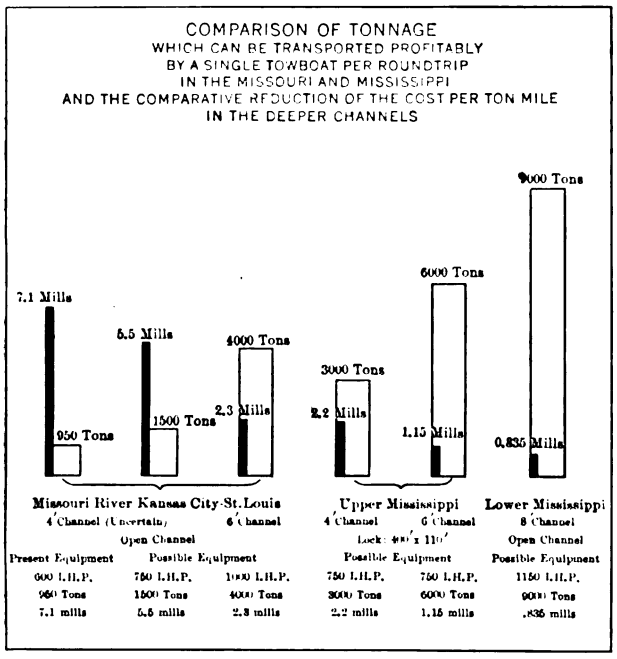

Fig. 3

distance 1,242 miles, requires 10 units; a service between St. Paul and St. Louis, distance 677 miles, requires 6 units; a service between Kansas City and St. Louis, distance 408 miles, requires 3 to 4 units. The fixed charges on this equipment are 3 percent for repairs, 3 percent for depreciation and insurance, 6 percent for interest on investment and 3 percent for overhead, or a total of 20 percent of $250,000 (£51,300), or $50,000 (£10,250) per unit per season.

Cost of Towing Service

Only two items compose the cost of the towing service:

(1) The cost of operation of the towboat, which for a 750-horsepower towboat of correct construction is $100 (20/16/8) per day (although there are antiquated boats which cost twice the amount per day), increases with the increase in horsepower, ranging from $80 (16/13/4) per day for a 500-horsepower towboat to $130 (27/1/8) per day for a 1,200-horsepower towboat, at the same time decreasing in cost per horsepower. A 750-horsepower towboat, with its daily cost of $100 (20/16/8), half of which is for fuel and the other half for wages, commissary and supplies, will maintain this daily cost in all classes of Western rivers, due to the well-balanced fuel conditions existing. The operating cost per unit is, therefore, constant for all classes of rivers and only variable with the amount of horsepower applied in the towboat and the length of the navigable season.

As an example of class *A*, take the lower Mississippi, with a 300-day season; of class *B*, the upper Mississippi, with a 210-day season, and of class *C*, the lower Missouri, with a 240-day season.

(2) The fixed charges being in either case $50,000 (£10,250) and the operating charges for class *A* $30,000 (£6,150), class *B* $20,000 (£4,100), class *C* $24,000 (£4,920), we have a total cost per season of $80,000 (£16,400), $70,000 (£14,320) and $74,000 (£15,140), respectively, with a corresponding ton-mileage capacity of 80,000,000 for class *A*, 31,500,000 for class *B* and 13,000,000 for class *C*, which gives us the self-cost per ton-mile: 1.00 mill for class *A*, 2.2 mills for class *B* and 5.5 mills for class *C*.

Reduction of Self-Cost for Class A

This self-cost can only be reduced for class *A* by selecting larger towboats and larger towing units. The larger towboat unit, one of 1,000 to 1,200 horsepower represents with all its towing equipment a value of $300,000 (£61,500), or a yearly fixed charge of $60,000 (£12,300).

The cost of operation increases to $130 (21/1/8) per day or in a season of 300 days to $39,000 (£8,000). The total self-cost per unit is therefore increased to $99,000 (£20,300). The ton-mile capacity, however, is increased to 120,000,000 ton-miles per season, and the self-cost is reduced to .825 mill per ton-mile, or 17.5 percent.

Improvement of the Western rivers accomplishes an automatic reduction of the ton-mile self-cost in the same ratio as the improved rivers advance from a lower class into a higher class. The upper Mississippi, with its 4-foot channel, now in class *B*, would advance with a 6-foot channel to class *A* and, but for the difference of operating efficiency, the ton-mile capacity and self-cost of class *A* would apply. The improvement of the lower Missouri to a depth of 6 feet will put this channel from class *C* into class *B*, and the class *B* rates will generally apply.

Fig. 3 shows a comparison of ton-mile capacities and self-cost of the possible towing units in the Missouri and Mississippi in graphic form.

(1) Missouri River.—In its present state of improvement and with the present 600-horsepower towing units in use the capacity per season is 10,800,000 ton-miles and the self-cost 7.1 mills per ton-mile. A possible 750-horsepower unit would have a capacity of 13,000,000 ton-miles and reduce the self-cost to 5.5 mills.

After its improvement to 6-foot depth a possible 1,000-horsepower unit would have a capacity of 36,000,000 with the self-cost reduced to 2.3 mills. The maximum improvement of the channel from its present to its proposed condition would, therefore, increase not only the ton-mile capacity of the present towing unit but permit the use of a larger towing unit, resulting in a reduction of the self-cost in the ratio of 1 to 3.

(2) Upper Mississippi.—The best equipment possible in this river, a 750-horsepower towing unit, would have a yearly ton-mile capacity of 31,500,000 ton-miles with a self-cost of 2.2 mills. The same equipment after the improvement of the river to a 6-foot channel depth would have double the ton-mile capacity, reducing the self-cost by one-half.

(3) Lower Mississippi.—The 750-horsepower towing unit has in this river a capacity of 80,000,000 ton-miles per season with a self-cost of 1 mill per ton-mile. A possible 1,200-horsepower towing unit would have a capacity of 120,000,000 ton-miles per season with a self-cost of .825 mill per ton-mile.

Cost of Down-Stream and Up-Stream Towing

The up-stream cost, as a rule, is 50 percent greater than the down-stream cost or the down-stream is two-thirds of

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the up-stream cost; or the down-stream cost is 40 percent and the up-stream cost 60 percent of the round-trip cost. Applied to class *A*, the down-stream cost per ton-mile is .66 mill and the up-stream cost .99 mill. Applied to class *B*, the down-stream cost per ton-mile is 1.75 mills and the up-stream cost 2.64 mills. Applied to class *C*, the down-stream cost per ton-mile is 4.4 mills and the up-stream cost 6.6 mills per ton-mile.

EARNING POWER OF A TOWING UNIT

The earning value of a towing unit depends first on the ton-mile capacity and second on the revenue per ton-mile. Anticipating water competition, railroads paralleling rivers have reduced rates between water points to such an extent that only a towing service offering lower rates and correspondingly good service can compete. Properly-dimensioned towing units or towing trains have a 5,000-ton capacity, or two and one-half times the capacity of the largest freight trains. The self-cost of towing is in class *A* reduced to .66 mill per ton-mile down-stream and .99 mill per ton-mile up-stream. One towing unit for each 100 miles of river guarantees a service of two- to three-day intervals. The self-cost of transportation in rivers of class *A*, .66 mill per ton-mile down-stream and .99 mill per ton-mile up-stream is far below the self-cost of rail transportation.

Average revenues obtainable on rivers of class *A* are not less than 2 mills per ton-mile, on rivers of class *B* 3.5 mills per ton-mile, and in rivers of class *C* 7 mills per ton-mile, leaving a 25 percent margin on rivers of class *C*, a margin of over 50 percent on rivers of class *B* and a margin of over 125 percent on rivers of class *A*.

Shed Capacity at Marine Terminals

Proportions of Quay and Pier Sheds to Give Most Efficient Service—Prevention of Congestion in Sheds

BY H. MCL. HARDING *

IT has generally been the practice to design piers the widths of which were determined chiefly by the available water area. The pier was often made too narrow for the length, the idea being that as many piers and as much berthing frontage as possible should be obtained without regard to other equally important considerations.

Similarly, the widths for the ships were often contracted to the narrowest limit. The natural result followed, viz.: great congestion on the piers and approaches, in the sheds and in the ships, which more than nullified any advantages of the increase in berthing frontage.

There were no general rules to follow, and each engineer was a rule unto himself. After the pier was planned, the floor dimensions of the shed were made to fit the pier —that is, as much of the pier as possible was covered by the shed to within a few feet of the sides of the pier. The height of the shed was generally fixed by custom at about 16 to 18 feet, unless there should happen to be two stories. There were frequently drayways and car tracks within the sheds.

HOLDING CAPACITY OF SHED

There seemed to be no conception as to what relation should exist between the holding capacity of the shed and the size of the vessels making use of the piers and shed. Even the proper function of the shed, which is a place only for assorting, distributing and tiering the cargoes and freight for short holding and not as a warehouse for long storage, did not seem to be fully recognized. To the lessee or owner of the shed it could have been said: "There is the shed, use it." If the shed was soon filled up with freight and there was the too often unnecessary congestion, the congestion must be endured or else another pier and another shed must be built. Quay sheds, even where there was ample room, were designed to conform to some customary sizes. Apparently, as quay sheds at a neighboring port had certain dimensions, such sheds were taken as models and imitated.

It is the object of this paper to ascertain whether pier sheds cannot be designed with reference to their greatest usefulness, and in other ways prevent the excessive shed congestion. In an address before the American Society of Mechanical Engineers in 1913, the chief engineer of the port of Hamburg stated that the practice at Hamburg was to have the capacity of the shed equal to twice the average capacity of the largest ship berthing in front of the shed, and that the length of the shed was about equal to that of the longest ship. This referred to ocean freighters with ships berthing on one side of the shed. This result was derived from careful observation and study of a large merchant marine.

NUMBER OF VESSELS SERVED BY SHED

It is evident that there should be a greater capacity for sheds on piers where there may be a vessel on each side of the pier opposite the shed than for quays where there is a vessel only on one side of the shed. That is, the one shed on a pier should have a capacity for four ships instead of two, if congestion is to be avoided.

On piers of such a width that there can be two sheds abreast with a space between them, each shed should have the same capacity as a quay-shed. This is the case at Kobe, Japan, being the design of English terminal engineers.

Where there is a large tonnage of both inbound and outbound freight, it is often advantageous, where conditions will permit, to have one shed for outbound freight and another for inbound cargoes. This has given excellent results.

While a certain proportion of the cargo of a barge may be for railway car loading, or for immediate direct transference to drays, yet there may be vessels the whole cargo of which may require shed protection without immediate car or dray transference and often there must be not only the inbound cargo in this shed but also outbound cargo, held for loading into barges or ships. With only one shed the outbound cargo should be tiered in that portion of the shed nearest the barge, and the inbound on the opposite side of the shed nearest the railway tracks and the dray area.

There are locations having ample water frontage, but where, due to shallow water, too much dredging would be

* President of the Society of Terminal Engineers, New York City.

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required for economical quay development. A long pier, 250 feet or even more in width, would be preferable, with two sheds abreast with a wide space between, to which reference has been made.

While there are many indeterminate factors as to shed capacity, yet fortunately the shed being designed for short holding and not for a warehouse, the time the freight can be held in the shed can be so limited as to greatly reduce congestion under ordinary conditions. It is recommended that the freight be held in the shed not more than forty-eight hours. If the freight be not moved by the consignee at the end of this forty-eight hours, it is then sent to the warehouse for storage, the expense for handling, transferring and storage being charged against the shipper, consignee or the goods. By giving this limit of forty-eight hours the authority of law, it will obviate discussion and congestion, thereby reducing delay and eliminating rehandling costs, and may render unnecessary the immediate building of additional terminal sheds.

For comparison as to the relative capacities of barges and pier sheds the following figures are given:

Relative Capacities of Barges and Pier Sheds

The net cubic foot capacity of a barge about 300 feet long, 42 feet wide and drawing about 11 feet, and limited to 15 feet head room under bridges, may be taken as 40 feet by 280 feet by 20 feet = 224,000 cubic feet. The gross shed capacity should therefore under these conditions be 300 feet by 80 feet by 20 feet, which equals 480,000 cubic feet, which is about double the barge capacity of 224,000 cubic feet. If the shed should be made 400 feet long, its capacity should be 640,000 cubic feet.

The vertical capacity is here attained by high mechanical tiering, which is by far the most economical method for increasing shed capacity. No floor space should be occupied by the tiering machinery or by railway tracks or for drays. The usual height of 5-foot tiering by manual labor would only give 120,000 cubic feet, which is only one-fourth the required capacity. Any higher tiering by manual labor than 5 feet so increases the cost of handling that any higher tiering is avoided whenever possible.

Pier shed capacity for a properly designed pier is independent of the length of the pier, the same as a quay shed is independent of the length of the quay. Longitudinal travel by cars or drays is kept outside the sheds, and similarly between the shed and the waterfront.

The above figures of capacity in the shed design can be adjusted and regulated by the time allowed for the freight to remain in the sheds, and the length, breadth and height of shed can be varied proportionately depending upon the volume of cargoes.

The sheds for freight (not for passengers, which often should be of two stories) should be of one story. One story with high tiering will give greater freight capacity and less costs for supervision and handling than where there are two stories. The initial investment will be much less.

As to inland lake or river freighters, the following data may be of service:

Freight, Tons	Length, Maximum Feet	Beam, Maximum Feet	Draft, Feet	Shed Capacity, Cubic Feet
2,000 to 3,000.....	365	50.	19.9	400 x 60 x 20
5,000 to 6,000.....	436	56.	20.3	450 x 80 x 20
9,000 to 10,000.....	500	56.2	20.9	500 x 80 x 20

If the length of the ship should be 320 feet, then the length of the shed may be that of the next above multiple of fifty—that is, 350 feet. The character of the cargo is that which would require shed protection and does not refer to ore, coal or coarse freight.

It will be noticed from the above that to get carrying capacity the length and beam is increased while the draft on account of the locks is not. For 9,000 to 10,000 tons the draft is 20.5 feet and for 15,000 tons it is only 20.8 feet. For ocean freighters the draft is more and the beam less.

Where there are two ships or barges, one on each side of the pier, then the length of the shed should be 50 percent longer than the longest vessel, with a width of 80 feet, and the height of tiering 20 feet. If the longest vessels to berth there should be 500 feet, with a miscellaneous cargo capacity of 5,000 tons, the shed dimensions should be

$$\left(500 + \frac{500}{2}\right) \times 80 \times 20 = 1{,}200{,}000 \text{ cubic feet.}$$

Making due allowances for aisles and working space, the ton may be assumed to occupy 60 cubic feet instead of the marine 40 cubic feet; therefore 5,000 × 60 = 300,000 cubic feet, and multiplied by four for the two ships would give 1,200,000 cubic feet.

Conclusions

1. A quay shed should have a cubic foot maximum capacity double the average freight-carrying capacity of the largest vessel expected to berth opposite to it.

2. A pier shed having a berth for a ship only on one side of the shed should have the same maximum capacity as a quay shed.

3. A pier shed having berths to be occupied on both sides of the pier opposite the shed should have a shed fifty percent longer than the longest vessel, giving approximately a capacity double the average freight capacity of both vessels combined, or four times the cubical capacity of one ship.

4. Unless there are freight-holding capacities approximating to the above, under average conditions there will be the usual congestion and the most efficient use of the shed will not be attained.

New Naval Dry Dock at Norfolk.—Plans for the new graving dry dock to be built at Norfolk, Va., call for a dock 1,000 feet long and 110 feet wide, with a depth of water of 43 feet 6 inches over the sills. The sills are 2 feet above the floor and the blocks along the floor are 5 feet 6 inches high, spaced 2 feet apart. The dock is to be closed at the end by a caisson and provision is made for an intermediate caisson which will divide the dock into two separate sections, one 650 feet long and the other 350 feet long. As the largest vessels in the Navy up to date, with the exception of the battle cruisers now being built, are less than 650 feet long, the larger part of the dock can be used for the larger ships while the smaller part can be used at the same time for smaller craft. The pumping plant of the dock is in separate units and the dock can be pumped out in one and one-half hours when no vessel is in the dock. It can be flooded in thirty minutes. The caissons are provided with equipment for flooding and pumping out the caissons themselves, the flooding of the dock being accomplished through numerous openings controlled by hydraulically-operated quick-acting valves. The pumping equipment in the caissons is electrically operated and designed so that the water can be pumped out of the caissons in fifteen minutes' time. A 50-ton electric crane equipped with a horizontal jib will travel around the dock. Electric capstans will be provided for handling the lines when docking a vessel.

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Mold Loft Notes

Methods of Developing Shell Plating — Lifting Bevels

BY T. L. COHEE

Definitions of Terms Used in Mold Loft

Tumble Home.—The distance the side of the ship falls inboard from the half-beam perpendicular in way of deck.

Flam.—The opposite of tumble home, that is, the fall out of the ship's side, which usually occurs at ends of ship.

Bow Line or Buttock.—The molded shape of the ship through a vertical plane parallel to the longitudinal center line.

Diagonal.—The molded shape of the ship through an oblique longitudinal plane extending from the center of ship to the middle of bilge on the midship frame generally placed as near right angle as possible for fairing purposes.

Boss.—That part of the ship where the frames are swelled out to permit the passage of the ship's shaft tube.

Dead Flat.—The straightest part of ship's form and the greatest section midships and the point where the frames turn in opposite direction.

Camber of Beam.—The crown or curvature of the deck.

Bilge.—That part joining the ship's side to the flat of the bottom.

Length Between Perpendiculars.—The distance on the load waterline from the forward side of stem to the aft side of stern post.

Length Over All.—The level length from the extreme point of the stem to the extreme point of the stern.

Molded Depth.—The vertical distance from the top of keel—squared out to the side—to the underside of the main deck stringer plate at the midship section or lowest point of the sheer.

Midship Section.—The fullest part of the ship taken transversely and centrally between perpendiculars, but there are cases where it is nearer the stern than the stem. It is supposed to be the lowest point in the sheer.

Molded Beam.—The greatest width of the ship from the outside of frame to outside of frame or inner side of skin on the midship section.

Change of Frames.—The change of the position of frames occurs amidships; those in the fore body stand with the toe of frame facing toward amidship and those in after body likewise face amidship. This is done so as to always have an open bevel on the frame to facilitate riveting of frame to shell.

Cant Frames.—Cant frames are those which are not square to the center line of ship. They are always fitted aft of the transom and are sometimes fitted forward on very full ships.

Body Plan

The body plan is the shape of the ship at cross section planes at each frame section. These sections show a half side of the ship only. Those forward of the midship section are generally shown on the right-hand side of the vertical center line and form what is called the forward body. Those aft of the midship section are shown on the left-hand side and form what is called the after body.

The body plan is the basis of all development work. At some yards it is scribed in on a scribe board, which is made in sections of about 10 feet square, so that it may be portable, and is composed of two layers of well-dressed white pine lumber each about one inch thick at right angles to overcome warping and covered with lamp black for preservation. At other yards it is scribed in on the regular floor, usually at one end of the loft and shellacked for preservation and to keep the lines bright.

This plan shows in full size all the frame lines, the longitudinals, decks, shell, inner bottom, and projection of rabbet of stem and stern post. It also shows waterlines and sectional or buttock lines, from which the original laying down is done, sight edges of shell and inner bottom plating, traces of port holes and inner edges of longitudinals and stringers.

The fore-and-aft outlines of the stem and sternpost should be conveniently near, generally at each side of the body plan.

Method of Lifting Fore-and-aft Measurements from Body Plan

The body plan gives the true form of all the frames and shows the projection on the midship section, or a plane parallel thereto, of all other lines. The exact distance between any two points on the same frame is obtained directly from the plan.

The exact distance between any two points on different frames, however, is not so given, but is easily obtained, as

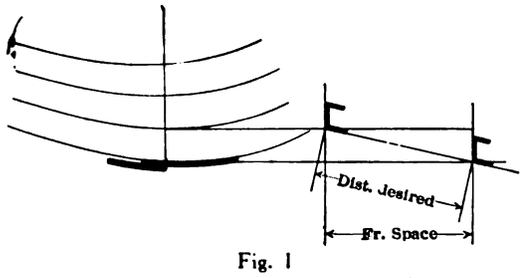

Fig. 1

shown on Fig. 1. The length of a line joining two points on two different frames is the hypothenuse of a right triangle of which one side is the projection of the line on the body plan, or the distance on the body plan between the two points, and the other side is the fore-and-aft distance between the two frames referred to, which is known from the frame spacing of the ship. Thus if the distance along a sight edge between two successive frames is desired, we measure the distance shown on the body plan between the intersection of the sight edege with the two frames and lay it down as the side of a right triangle of which the other side is one frame space. The hypothenuse is then the distance desired.

Templates

Templates are made of various materials, depending on the amount of use to which the template may be put. If for a pair of plates (port and starboard), the paper template is most convenient. For small brackets, clips and liners, or long angles, templates of wood are best, usually bass wood of about ⅜-inch thickness.

The template of any shape or plate is a full-size plan showing in detail all rivet holes and cut outs, outlines of

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edges flanging or rolling lines and gives the necessary information for laying out.

The paper used for templates costs about $17 (3/10/10) per roll of 2,000 square feet, usually about 105 inches wide, but is also manufactured in other widths if desired. This paper expands and contracts according to the dampness,

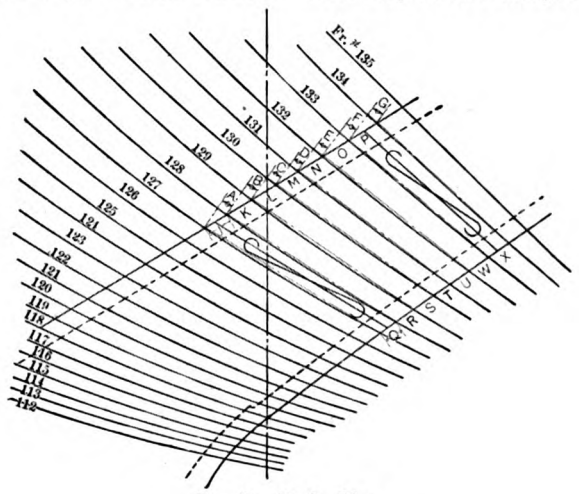

Fig. 2.—Body Plan

temperature, etc. For overcoming this fault a series of check lines, with length and breadth marks thereon, is placed on each template. When the template shrinks, caused by heat and dryness, the template is covered by a tarpaulin and water sprinklered thereon and the dampness allowed to permeate the templates. This method is better than sprinkling the water direct on the template, because if it is possible that the template may be used again for another ship later on the template will respond to treatment better.

It is the practice of the layerout to lay out all the plates at once rather than lay out one now and one a day or two later, especially if the template needs treatment. The paper does not respond to the wetting treatment the second time as well as the first time.

When the paper expands it is best brought back to its proper length by the application of heat, generally by standing it beside a steam radiator or on a furnace while rolled up loosely. By actual experience the temperature most suitable to keep the paper normal is about 60 to 70 degrees F.

The paper when subjected to the rays of the sun will shrink as much as ¼ inch before the layerout can finish center punching. For that reason it is best laid off in the shop. Recently at a certain yard on account of lack of shop space the plates were laid off on an open platform directly in the sun. To overcome this the work was laid off in the early hours of the morning, and laid off in the shop in the heat of the day.

Development Lines

In the development of a template certain reference lines must be obtained from the body plan and laid out in their relative positions, from which the details of the template can be laid out. These lines are the longitudinal plate edges of shell and deck, etc.

Detail plans of the sections to be laid should be convenient for filling in the details of the template; thus, when a template of a stringer is to be laid out, the framing plan, stringer plan, the shell expansion and similar plans should be on hand in order to place the rivet holes, cut out, etc., and the necessary information in detail essential for the laying out of template.

In the following description the detailed work of placing the width of laps, rivet lines and outlines of cut outs etc., will not be touched upon, as the method of doing this work is obvious, once the development work of obtaining the various lines on the template is done.

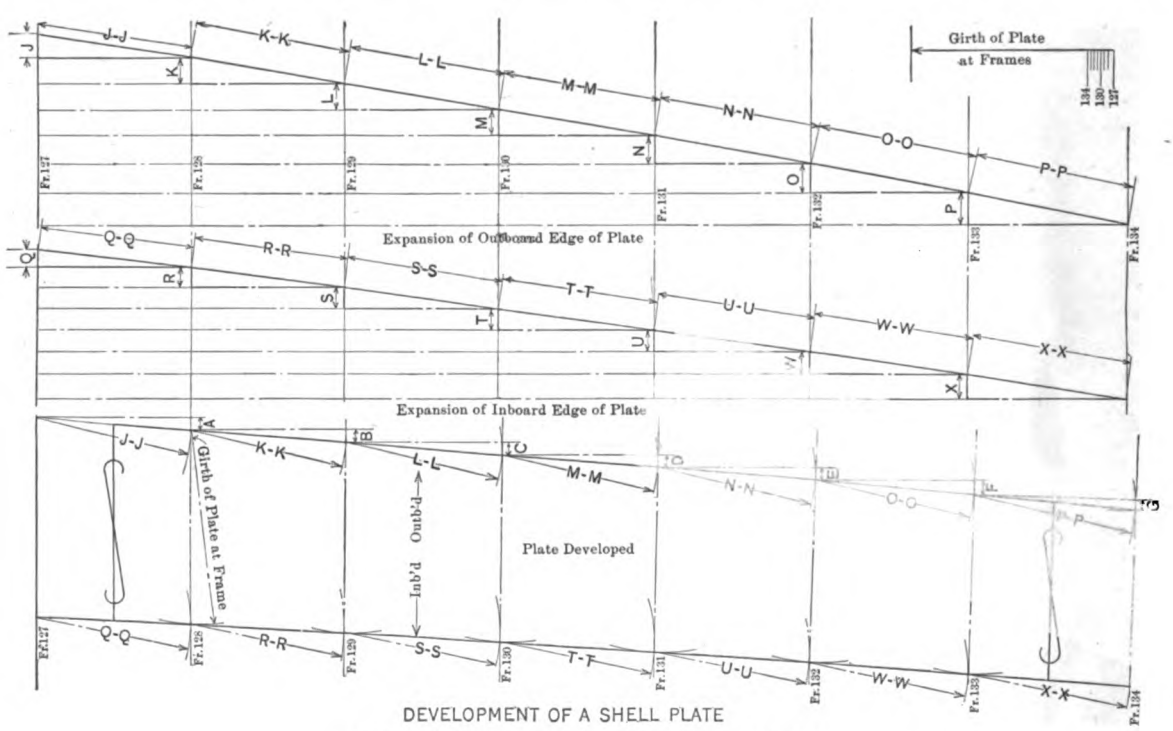

Fig. 3.—Shell Plate Developed by Squaring Method

Shell Plate Development—Squaring Method

The plate shown in body plan (Fig. 2) was taken from a section at about two-thirds length aft just after leaving

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bilge. The developed plate (Fig. 3) is on the same scale as the portion of the body plan shown. The figure shows the actual development of a shell plate—not merely an illustration of how a plate is developed.

In developing a plate it is customary to develop the surface to the frame beyond each butt. In this case the surface between frames (127 and 134) is developed.

The first step is to draw a straight line from the top to the bottom of the edge of the plate at each frame, then from each of these lines square over to the next frame and note the distance above or below, as the case may be, in this case below. The differences on this plate were taken on the top or outboard edge, but could be taken on the lower or inboard edge of the plate just as well. Beginning at frame 127 and square over frame 128 (lifting distance *A*), and from frame 128 to 129 (lifting distance *B*) and so on, with each successive frame to frame 134 (distance *G*).

The next step is to lift the distances along the edge of the plate at the top and bottom on the body plan as at frame 127 to 128 shown as *J*, and from frame 128 to 129 shown as *K*, and so on, to frame 133 to 134 shown as *P*. Proceed in the same manner along the lower edge of the plate at *Q*, *R*, *S*, and so on. This, of course, is not the true length of the plate edges. Each of these distances represents the base of a right angle triangle, and the altitude is the frame spacing of the ship—in this case three feet. To get the right conception of this, imagine the body plan as a huge accordeon and open it out to its limit, each frame space (three feet) apart, then the line shown on the expansion of the outboard edge of the plate at *J-J*, *K-K* and *L-L*, etc., will be the true length along the top edge of the plate.

Proceed in the same manner to get the expansion of the inboard edge of the plate. Lift the distances on straight lines at each frame on the body plan. Lift also the actual girth of the plate on each frame—in this case there is not any practical difference. Having the girth at the respective frames, the difference in height of one frame to another and the length from one frame to another along the top and bottom edges, you are now ready to develop the plate in full size.

Begin by drawing a straight line and thereon place the girth of frame 127, then from this line at the top point erect a perpendicular line, produced a little greater than one frame space. Parallel from this line strike in distance *A*, then from the top point on frame 127 strike in distance *J-J*, intersecting distance *A* at frame 128. From this point strike in the girth of frame 128, intersecting *Q-Q* at the bottom edge of the plate. Proceed in the same manner with the others as shown.

It will be seen that the plate butts between frames 127 and 128 on the forward end and between frames 133 and 134 at the left end. The butt can now be placed at any point between the frames indicated by the shell plan and is measured square to frame and placed parallel to adjoining frame.

When the curvature of the frames is pronounced, that is, when the girth of the frame is in excess of the straight line drawn from the edge of the plate at the top to the edge of the plate at the bottom, as shown on the body plan, the excess is added equally to the edges of the plate after development.

SHELL PLATE DEVELOPMENT—TRIANGULATION METHOD

When shell plates are located some distance from the parallel middle body, that is, when their projection in the body plan has appreciable dimensions, their development is best obtained by triangulation. Fig. 5 shows the full development of a plate on an inside strake. The plate at the top shows how it appears on the shell expansion plan. The method of obtaining the length along the top and bottom edges is the same as explained on Fig. 3.

On the body plan (Fig. 4) a series of diagonals is struck in, as shown from 1 to 8. These diagonals represent the bases of right-angled triangles. The altitude is the frame spacing of the ship and the hypothenuse is the length desired. The diagram at the bottom of Fig. 5 shows the true development and method of applying the true distances.

Beginning at the left, on the vertical line marked frame 127, placing thereon the true girth of the frame, with this line as a base proceed by swinging in distance *J-J* at the bottom intersecting diagonal 1 at frame 128. From this intersection at the bottom of frame 128 erect girth of frame 128. Proceed in the same manner with the

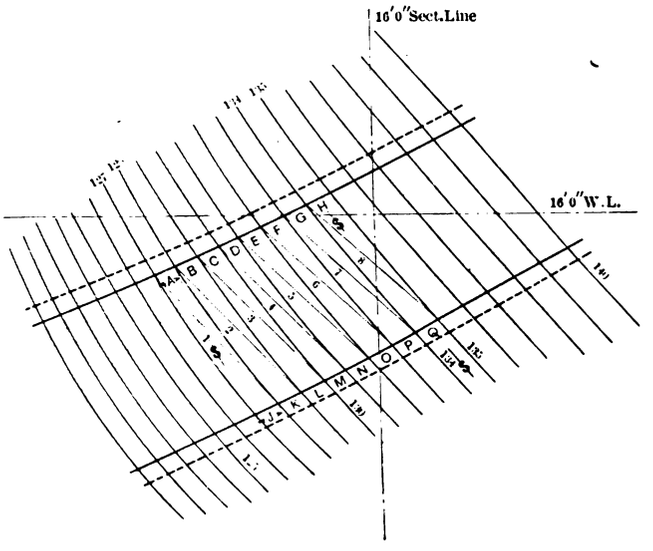

Fig. 4.—Body Plan

others. It will be observed that this plate is developed from sight edge to sight edge, and that to be complete the width of lap at the top and bottom edges should be added to the development.

It is better practice to check results by striking in the opposite diagonals, or take an opposite diagonal the full length of plate as at *A-B*.

Shell plating or longitudinals are best developed in long lengths, or in a continuous strake, rather than a single plate. This is governed, of course, by the space of the loft. The methods used in developing shell plate apply equally to stringers, longitudinals, stern plating, etc.

By the use of stiff but flexible battens along the top and bottom edges, fastened by a nail to the floor at each intersection, the operation of developing a plate on the floor is not as difficult as one would surmise by its appearance, as shown in the figure.

A table of distances for the triangles can be figured out previously for the projection expected by observing the minimum and maximum projections on the body plan. Indeed, it is possible that from this table a set of figures can be obtained for each individual plate and can be placed on the shell expansion plan or sent out to the layer out in tabulated form; this information to give the true outline of the plate and measurements of any longitudinal or stringer crossing thereon. The layerout, with this information at hand, can then place it direct on the material, thereby dispensing with such extensive mold-making and material. There would be necessary only a loose-butt

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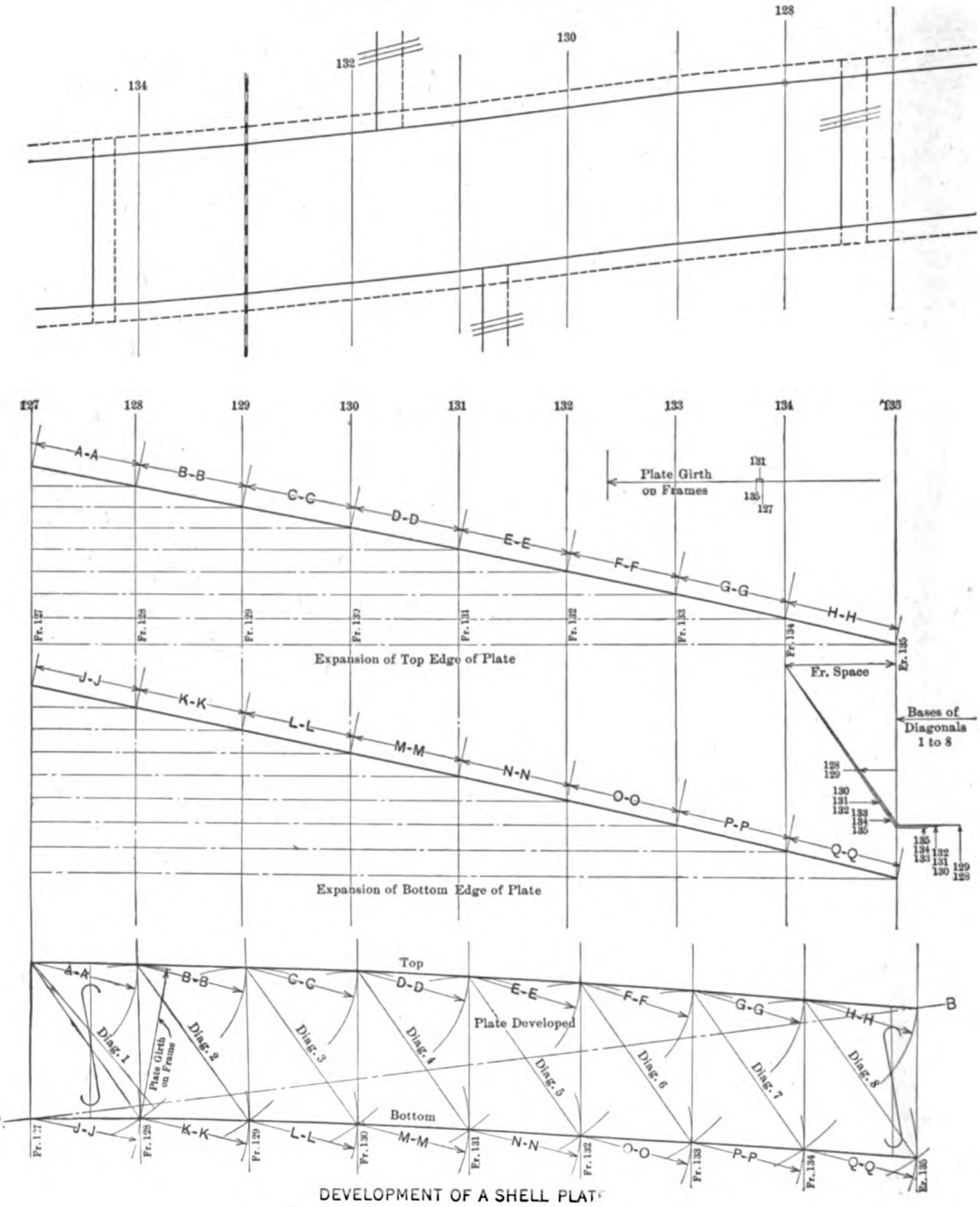

Fig. 5.—Shell Plate Developed by Triangulation Method

mold, lap-edge mold to be applied at every frame space, a frame mold and frame-space longitudinal mold.

Certain yards develop the inside strake of shell plating only in the mold loft and depend on this strake as a rib-band and guide to pull the structure together properly, and then any inaccuracies or defects that may develop are overcome by templating the outside strake from the ship. To a yard that follows the above custom, this direct method would be economical as well as providing a more equal distribution of work, besides the important feature of laying off but one plate, the mate or mates thereto being duplicated from the original plate after punching. If there may be more than one hull, the advantage in multiplicity is at once obvious. The cost of the handling of the original plate as a template is nil, especially as the duplication can be performed by unskilled labor.

Lifting Bevels

The frame bevels are lifted in the loft by a bevel stick made of [illegible] The method of making one is shown in [illegible] applying this stick on the body plan and measuring the distance between any two frames the bevel is immediately ascertained in degrees. The number of degrees of bevel is stamped on the mold at that particular point for the frame hands's information.

Angle bars are assumed to be [illegible] are opened or closed, as shown in Fig. 8. In measuring degrees for flanging plates, the plate is considered [illegible] when in a flat state and is measured thus, as illustrated in Fig. 7.

Curved Frames' Lines on Shell Plates

Forward and aft, that is, after leaving the parallel middle body or dead flat section adjacent to the bilge and forward in the flam of the bow, the frame lines develop not as straight lines but as curves. This can be readily seen from the following: Assume the ship's surface as a sec-

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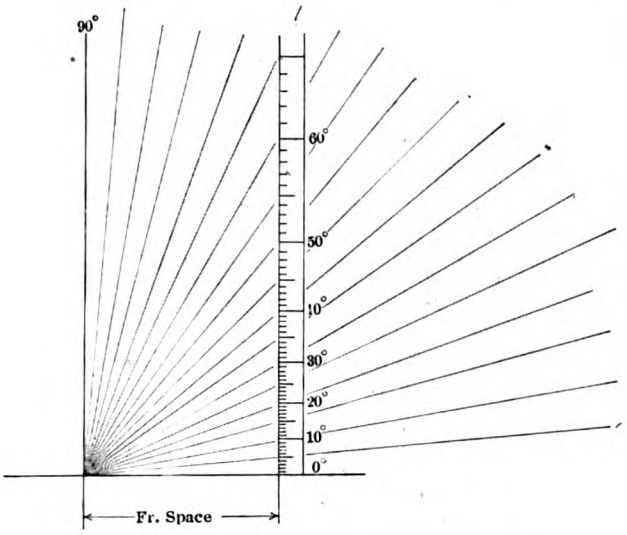

Fig. 6.—Method of Making a Bevel Stick

tion of a cylinder, the developed line of a plane cutting this cylinder normal to the axis of the cylinder will, of course, naturally develop as a straight line. But forward and aft the plane of the frames is not normal to the axis of a cylinder, consequently the frame line will not develop as a straight line.

In Fig. 9 is shown a frame exaggerated as to curvature, to make it more pronounced at a section where the frame is not normal to the shell surface. The figure to

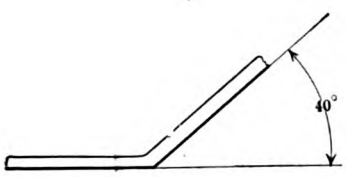

Fig. 7

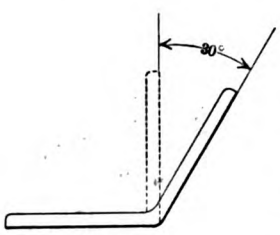

Fig. 8

the right shows the plan view of this section with the plate edges at Z at top and Z at bottom and assuming a water-line or datum line at X. The frame $Z\ X\ Z$ is not normal to the shell surface, the normal plane being $Z\ A$, which will develop as a straight line. The frame line $Z\ X\ Z$, however, will develop as a curve. The distance $X\ A$ is

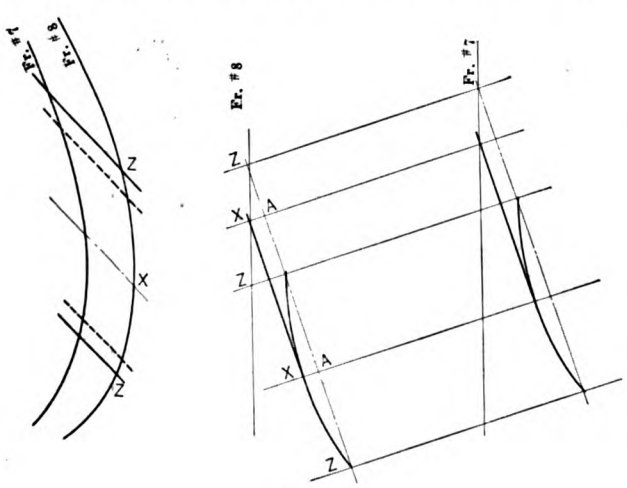

Fig. 9

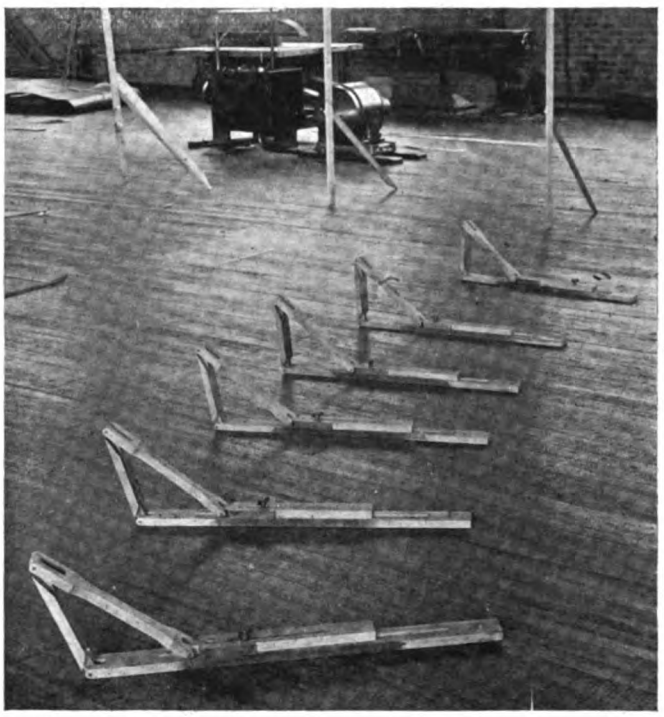

Fig. 10.—Bevel Blocks in Position for Lifting Shell Flanges

therefore the difference between the normal plane and the actual plane of frame. It is then simple to place the distance $Z\ A$ on the template and springing a batten through the three points $Z\ A\ Z$. This repeated at each frame will give the desired curvature.

This method is much simpler and entails far less labor than the method shown in Fig. 10, which is self-explanatory.

ERRATA.—In the article on "Straight-Lined Model Experiments," page 341, August issue, the tabulated data in the upper right hand corner of Fig. 3, at the top of the page, are in error in that the letters E and D in the first column have unfortunately been transposed, making the fuller vessel appear to be the more easily driven, which, of course, is contrary to fact. The data in the upper line of this table refer to type D ship, while the figures in the lower line apply to type E ship.

In Fig. 4 on the following page the lower curves marked E. H. P. should be marked F. H. P., as they represent the frictional horsepower. The other curves in the figure represent the total E. H. P.

In the article on "Reinforced Concrete for Shipbuilding," page 303, July issue, Table I, at the top of the page, is in error with respect to the following items, which should read as follows:

	Reinforced Concrete	Steel
Interest on repair cost at 5 percent..	$ 750.00	$ 1,154.00
Total cost	25,152.00	44,549.00
Annual cost	718.63	1,781.96

PORT AND TERMINAL EFFICIENCY.—Advancement of port and terminal efficiency will be discussed at the annual convention of the American Association of Port Authorities, to be held at Cleveland, Ohio, September 11 to September 14. Special consideration will be given to legislation requiring common carriers and steamship lines to use their terminal facilities in such joint manner as will promote the utmost efficiency in the handling of all commodities.

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MOTORSHIP S. I. ALLARD

Designed and Built by St. Helens Shipbuilding Company, St. Helens, Ore.

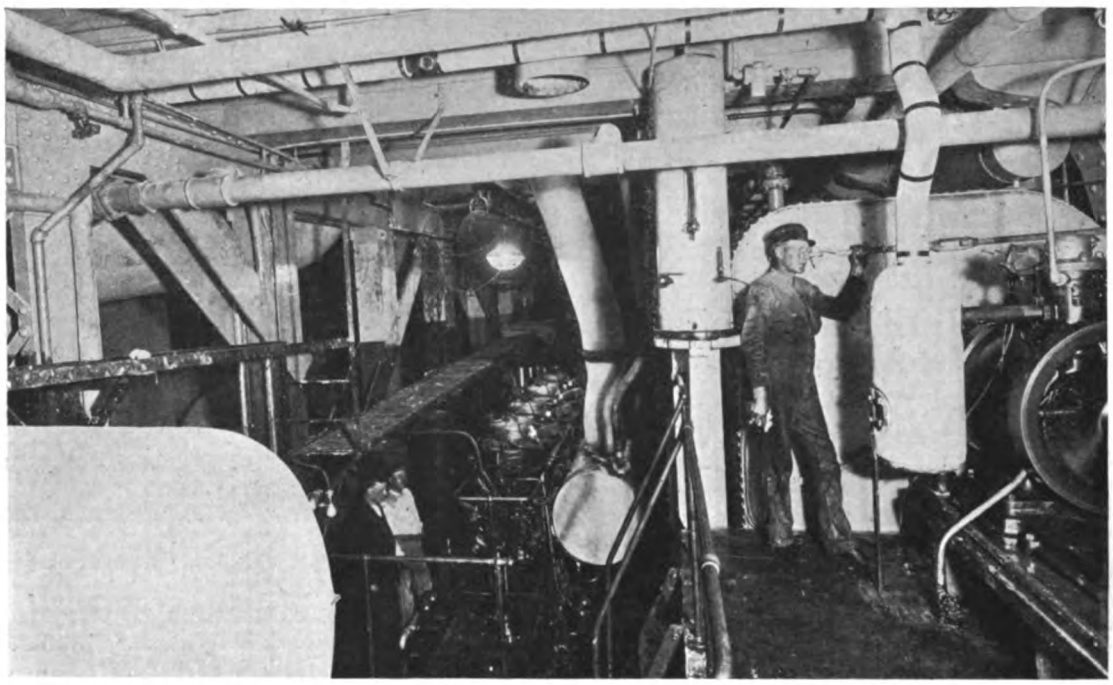

Fig. 1.—Engine Room Looking Aft, Port Side. Auxiliary Unit at Right

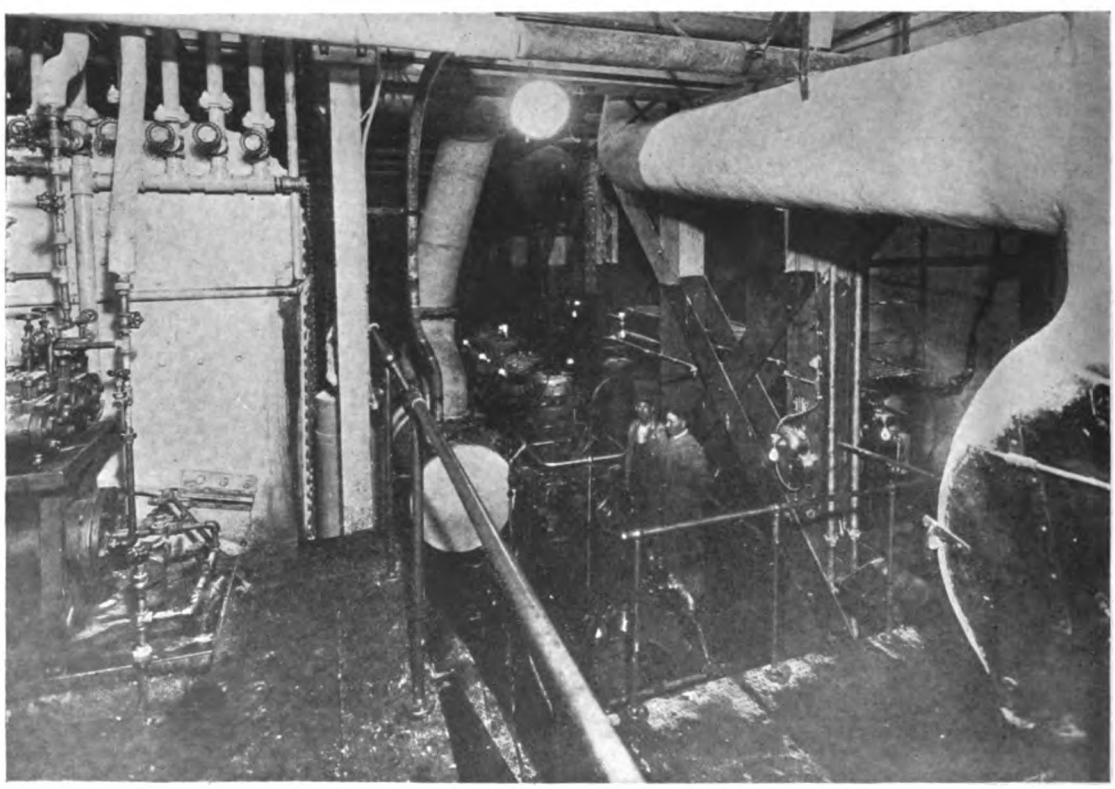

Fig. 2.—Engine Room, Looking Aft, Starboard Side. Donkey Boiler at Right

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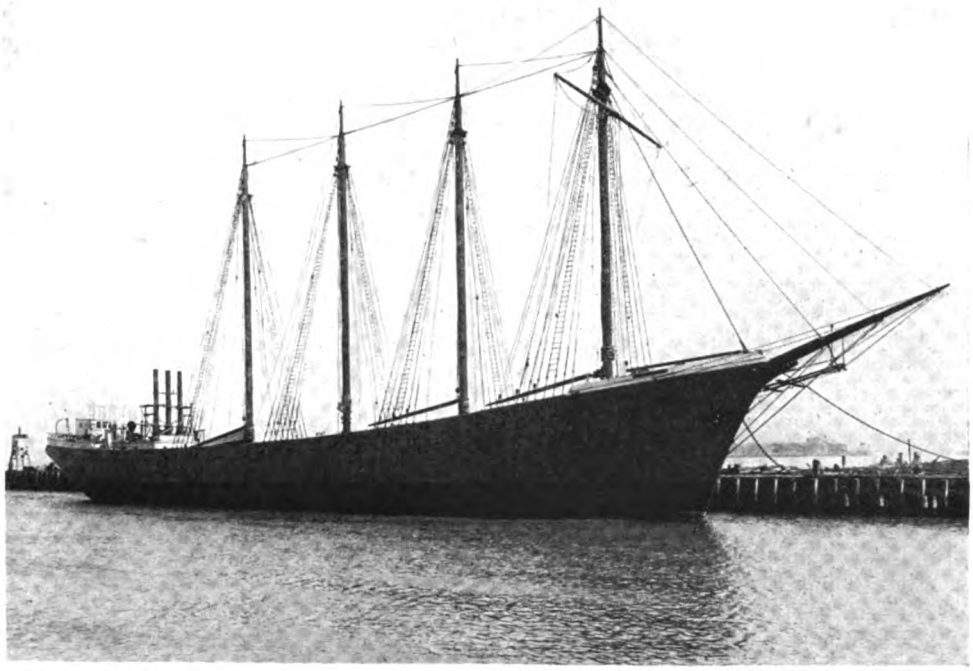

Fig. 3.—Motorship *S. I. Allard*

Maiden Voyage of Motorship S. I. Allard

THE wooden motorship *S. I. Allard,* designed and constructed by the St. Helens Shipbuilding Company, St. Helens, Ore., for Charles R. McCormick & Co., San Francisco, Cal., recently completed her maiden voyage to Sydney, Australia, after being twenty-six days out from Honolulu. The run from the Columbia River to Honolulu was made in thirteen days. At Honolulu the vessel stopped for spare machinery parts and equipment which had arrived in San Francisco too late to be placed aboard the vessel before sailing. The total sailing time of the vessel from the Columbia River to Sydney, Australia, was thirty-nine days, which is considered an exceptionally good performance and indicates that the auxiliary

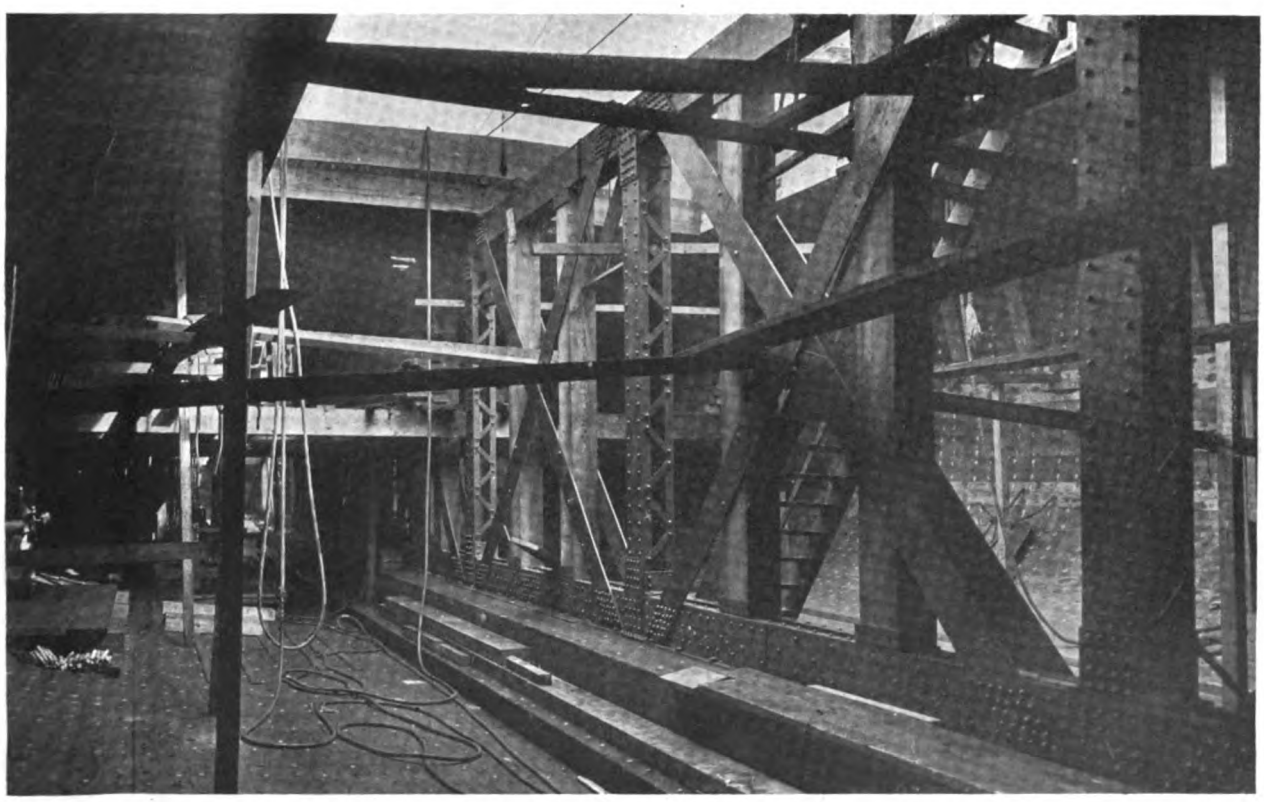

Fig. 4.—View of Hold, Showing Centerline Steel Truss

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schooner type of motorship will prove a strong competitor for overseas transportation.

Charles R. McCormick & Co., owners of the vessel, are pioneers in the development of this type of motorship. The *Allard* is a duplicate of the motorship *City of Portland,* which has already carried two cargoes of Douglas fir lumber to Australia, and also of the motorship *City of St. Helens,* recently launched by the St. Helens Shipbuilding Company for the same owners.

The *S. I. Allard* is 278 feet long overall, 246 feet 5 inches long between perpendiculars, 47 feet 3 inches beam molded, and 21 feet 11 inches depth molded. On her maiden voyage she carried 2,000,000 board feet of Douglas fir with a mean draft of 22 feet 6 inches. She has a tankage capacity for 1,660 barrels of fuel oil (20 degrees Baumé gravity), and on an average consumption of one barrel of fuel oil per hour under full power is capable of making any port in the world.

The vessel is four-masted, baldheaded, schooner rigged. Her sister ship, the *City of Portland,* has five masts, but in the *Allard* the fifth mast was discarded and in place of it a funnel was installed for the discharge of the exhaust gases from the auxiliary engines.

In addition to her sail power, the vessel is propelled by two sets of 320 brake horsepower Bolinder hot hulb internal combustion engines driving twin screws which give her an average speed under engine power alone of 8 knots and from 13 to 14 knots under engine and sail power in a fairly stiff breeze.

For handling cargo, she is equipped with four 8-inch by 8-inch vertical steam winches of the Pacific type, an 8-inch by 8-inch steam anchor windlass and a 5-inch by 7-inch steam capstan, all of which are operated by a 66-inch diameter dry back horizontal donkey boiler, carrying 130 pounds of steam, located in the engine room. For operating the auxiliaries at sea, compressed air at 150 pounds pressure is used, the air being taken from the compressors of the main engines. For this reason it is unnecessary to carry steam on the donkey boiler at sea. The auxiliaries also include two electric generator sets of 5 and 7½ kilowatts capacity respectively, and an electric steering gear of the Hewitt type.

The machinery installations on the *Allard* and her sister ships have been under the personal supervision of Mr. W. R. Hewitt, consulting engineer for Charles R. McCormick & Co., and he has watched closely the operation of these engines from the time of the construction and first trip of the *City of Portland* to date, making such changes and improvements as experience has shown to be desirable. On her trial trip, held over a measured mile course in San Francisco Bay on April 26, the average speed of the *S. I. Allard* for a period of five hours was 9.63 miles per hour.

Salvaging the Submarine H-3

Stranded Vessel Lifted Out of Quicksand and Hauled Over a Mile Across Country on the California Coast

DURING a heavy fog, on December 14, 1916, the United States submarine H-3 went ashore on Samoa beach, near Eureka, in Humboldt County, California. On December 28 bids were opened by the United States Government for salvaging the vessel either by putting her afloat in the ocean or hauling her from her position on the beach across the sand pits separating the vessel from Humboldt Bay, a distance of about one mile, and launching her in Humboldt Bay.

Six bids, ranging from $18,000 (£3,700) to $72,000 (£14,800) were submitted for the latter operation. The lowest bid, however, which was submitted by the Mercer-Fraser Company, of Eureka, Cal., was so much lower than the others that the Government was skeptical about the contractors' ability to carry out this work, and therefore decided to attempt to salvage the vessel themselves by towing her to sea.

For this purpose, the United States cruiser *Milwaukee,* the monitor *Cheyenne* and the naval tug *Iroquois* were sent to Eureka. Two steel cables 2 inches in diameter and 4,000 feet long were attached to the submarine and to the stern of the *Milwaukee.* During a heavy fog on the night of January 13, after the *Milwaukee* had been pulling on the lines for about two days, the *Milwaukee* drifted into

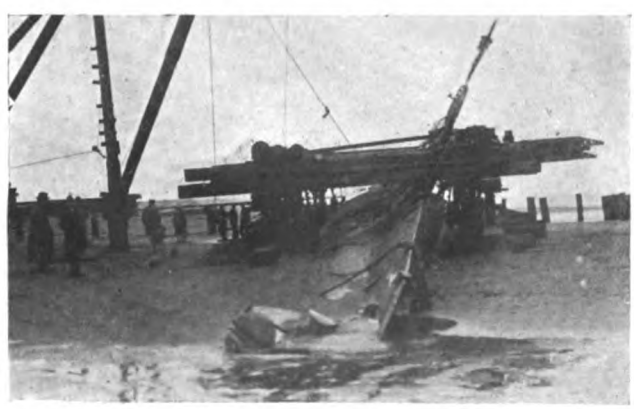

Fig. 1.—Timber Crib Work Over Submarine

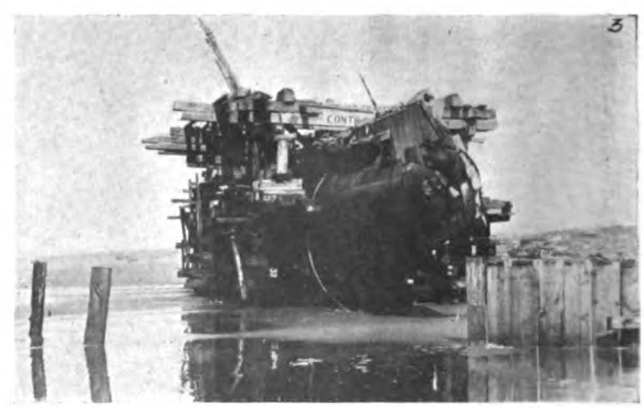

Fig. 2.—Submarine Lifted from Quicksand

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the breakers, due to the weight of the cables and the strong current. At the time of this mishap the tug *Iroquois* was connected to the bow of the *Milwaukee* with a long towline, which parted, and before another line could be attached the *Milwaukee* hit the bottom and within a few hours she was well into the breakers, finally becoming a total wreck.

On January 23 the Government again opened negotiations with the Mercer-Fraser Company, and on January 26 signed a contract with this company for salvaging the submarine at their original bid. Between the time that bids were originally opened and the signing of the contract the submarine had shifted north on the beach about 300 feet, and had settled into the sand about 6 feet deeper, which made the salvaging work much more difficult. At low tide the water rested for a distance of about 75 feet outside of the boat, and at high tide it came up on the beach about 250 feet inside the boat. Figs. 1 and 3 show how deeply the submarine had settled in the sand.

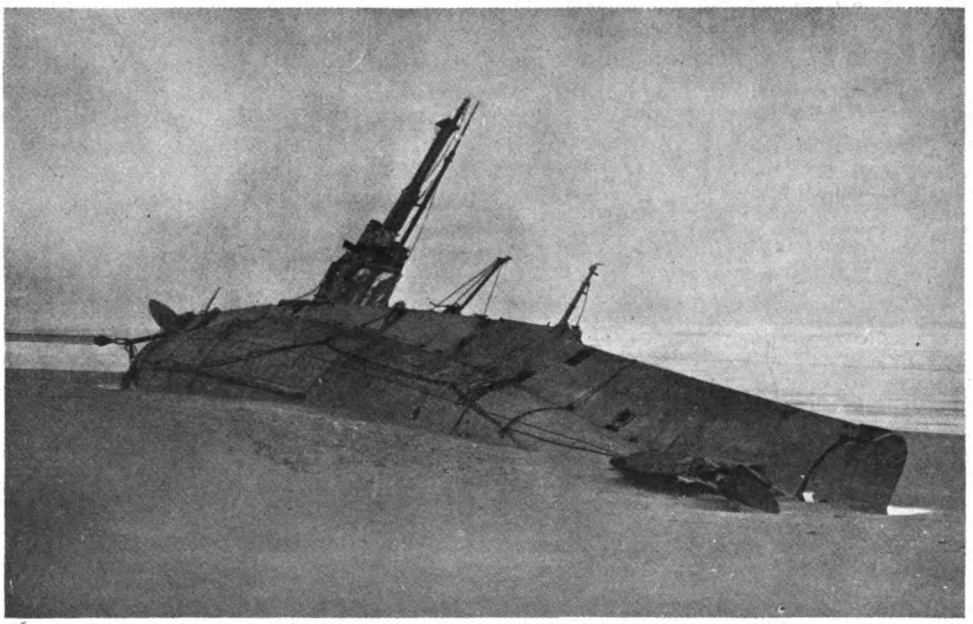

Fig. 3.—Position of the Submarine When First Embedded in the Sand

The first operation carried out by the contractors was to place seven steel cables, each 2 inches in diameter, around the submarine, for the purpose of lifting her out of the sand. Placing these cables under the vessel was not only the most difficult part of the work, but it was the feature which made the task seem to others almost impossible. Owing to the fact that the beach was of quicksand formation, it was impossible to excavate around or under the boat, or to pump the water out of such excavation, because this would only tend to cause the submarine to sink deeper into the sand.

The manner in which this difficulty was overcome shows the resourcefulness and ingenuity of the contractors. A force pump was set up on the beach and two lines of 2-inch hose attached to it. To the end of this hose two long joints of pipe were attached, and on the end of the pipe a small cable was attached. The pipe was placed in position where it was desired to place the cable, and at such an angle that when the pump was started and water turned into the pipe, the pipe would work down into the sand so that the end of the pipe with the cable attached to it would come just under the keel. Water was then run slowly through this and a pipe was jetted down from the opposite side of the submarine at such an angle that the end of it would intersect with the end of the other pipe to which the cable was attached. This made a hole in the sand large enough to admit a ¾-inch rod hooked at the end. By fishing with this the end of the small cable was hooked and pulled through under the submarine. It

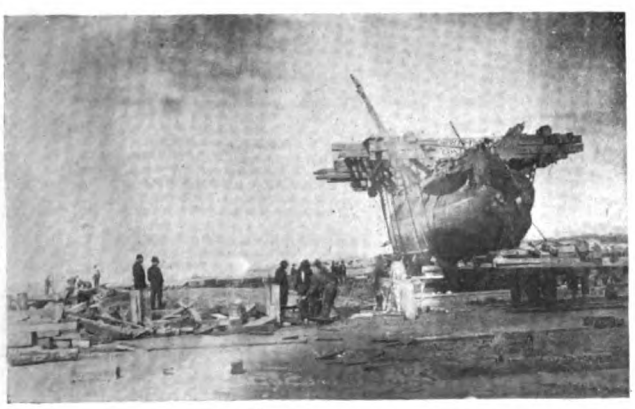

Fig. 4.—Vessel Moved on Rollers 150 Feet Up the Beach

Fig. 5.—Arrangement for Transporting Submarine to Humbolt Bay

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then became a simple matter to pull the 2-inch lifting cables around the submarine in the desired positions.

After the cables were in place a timber crib work was built, as shown in Fig. 1, to provide a means for lifting the submarine with screw jacks. The cross timbers were built up in units of four. Each timber was 12 inches by 12 inches in section and was of sufficient length to extend over the full width of the boat. Fourteen Norton ratchet screw jacks, with a capacity of 50 tons each, were used, and as the boat was estimated to weigh over 400 tons a good margin of safety was provided in the necessary lifting power and also in the strength of the lifting cables, as each of the seven cables had a breaking strength of 140 tons. Fig. 2 shows the arrangement of the cribbing, etc., when the submarine was raised from the sand and ready to be hauled up on to the beach. The foundations for the jacks were placed on piling driven on each side of the ship.

Critical Point of the Salvage Work

The critical point of the salvaging operations occurred at the time when the submarine was lowered on to rollers for hauling her up sideways on to the beach. While this operation was being carried out, the submarine was exposed to the tide, and, as the tide remained down only two and a half hours, any delay in the operations would have made it impossible to protect the submarine and she would have again settled down into the sand. This operation was carried out without a hitch, however, and Fig. 4 shows a view of the submarine after she had been moved about 150 feet up the beach.

After the vessel was above the high water mark on the beach the timbers were removed, as shown in Fig. 5, and a pine log, 80 feet long and 40 inches diameter at the small end, was placed on each side of the boat. Cables were placed around these logs and under them at each end were placed bobbers made up of four pieces of 14-inch by 14-inch timbers 20 feet long, solidly bolted together. As can be seen from Fig. 5 all the weight coming on these bobbers was carried at the center, permitting them to equalize when the grade was changed. The bottom of the timbers were shod with maple.

The Mile Journey Overland to Humboldt Bay

For moving the submarine across the sand pits a distance of a little over a mile to Humboldt Bay, a track consisting of three pieces of 6-inch by 16-inch pine was laid and the submarine was moved on rollers, each 4 feet long and 8 inches diameter, of California laurel, spaced 4 inches apart under the bobbers. Power was furnished by a hoisting engine operating through a pair of five-sheave blocks. As no attempt was made to grade the sand hills down to a perfect level, the vessel was moved with this tackle over grades as high as 4 percent. The submarine moved on an average of about 550 feet per day, the longest distance covered in one day being 1,060, while on another day 930 feet was covered.

On April 20 the submarine was launched in Humboldt Bay, the job having cost a little less than was originally estimated, therefore giving the contractors a good margin of profit.

This remarkable salvaging work was planned by Mr. James D. Fraser, president of the Mercer-Fraser Company, and carried out under his personal supervision.

Italy Building Standard Ships.—The Italian dockyards are constructing steamships of a uniform type of about 8,000 tons deadweight carrying capacity, the first of which has recently been completed.

Improving Purchasing Methods

BY H. B. TWYFORD

One of the most important economic problems of the business world is that of bringing into closer relationship and forming better connections between buyer and seller. Practically every manufacturing establishment and every concern with a commodity to sell has a very much larger percentage of wasted effort in placing its product on the market than it would have if better buying methods prevailed.

While great improvements have been effected in recent years in purchasing systems, and many departments are operated at a very high degree of efficiency, nevertheless conditions surrounding the work are far from ideal and the particular features of it, which have such a large influence on the economic operation of business, are too often neglected or receive insufficient attention. This is particularly noticeable in connection with two features of a purchasing agent's activities. One of these is the frequency with which incomplete or incorrect specifications and descriptions are allowed to pass through his office and be issued to those concerns from whom he asks for quotations, prices and information, and the other is the loose manner in which the firms are selected who are invited to cater for his business.

Accuracy in Specifying and Defining Goods

The requisitions which are sent to the purchasing agent are his authorizations to buy and form the basis and groundwork for all purchasing operations. It is necessary, therefore, to start with these in good order. If they are not so, as is often the case, they must be beaten into proper shape when they first arrive in the department.

Generally speaking, purchasing agents are commercially rather than technically trained, and all those requisitions for material which require specifying in detailed technical terms should be accompanied by proper specifications furnished by the engineering department. If the use of this material has been definitely determined and established, the purchasing department should keep on hand a sufficient number of copies of the specifications to enable it to make purchases without delay. The closing of a large contract by the sales department may make it necessary to buy certain materials quickly, and in such cases the purchasing department should be in a position to act promptly and not be dependent on some other department to furnish specifications with the usual attendant delay.

Specifications can be divided into two classes, those described in the last paragraph and those which are covered by well-recognized trade customs and usages. The latter embraces a large variety of materials and innumerable small articles, and it is in connection with these that most of the trouble occurs. Different names are used for the same articles; methods of specifying dimensions vary considerably and the description of quality, style or finish is frequently given in a variety of ways by persons in the different departments of the same establishment.

There is no good reason why this should be so, and to overcome the trouble some firms have adopted standard definitions for everything they use. These standard definitions are printed in some convenient form and distributed to all interested parties for reference purposes. These are excellent, but they are purely reference data and, like all similar data, are not always referred to when in doubt or are neglected because a man thinks he is sure of the proper definition, whereas quite often he is at fault.

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But although the adoption of standard articles may be secured, *standard methods of describing them are not.*

The responsibility, therefore, devolves upon the purchasing department, and it is in an excellent position to handle the matter, as it is in constant touch with manufacturers and is better posted and acquainted with the recognized trade descriptions and methods.

The manner in which this can be done is by the use of purchase order record forms. It is good practice to refer all requisitions as they come into the department to the clerk who keeps this record. He is then able to note on requisition where the material was last bought, the price paid, time required for delivery, and can at the same time *check the specification.* There are several other forms which could be used for the purpose indicated, such as the price records, record of sources of supply, or the stores inventory, and the selection of one of these can be governed by the methods which may be in use in handling the purchasing work.

Except for some miscellaneous items a separate sheet should be used for each article purchased and the standard definitions can be printed or written thereon. With the checking of the requisitions against these when they first arrive in the department an infallible method is enforced which absolutely prevents improper, incomplete or inaccurate definitions being issued with requests for prices or with orders.

In specifying and defining these small articles and certain regular commercial material, the manufacturer's standard practice should be adopted wherever possible, with such modifications as individual circumstances require. The descriptions should always be as concise as possible. In many cases two or three words or figures may suffice. The article should be clearly described beyond danger of misconception in the fewest possible words. An unnecessary word will often create an element of doubt and frequently the omission of one will mean that the description could be used to cover several grades or varieties.

GETTING THE RIGHT COMPETITION AND SELECTING SOURCES OF SUPPLY

The other feature of purchasing alluded to in the first part of this article is in connection with the selection of those firms with whom a purchasing agent negotiates for prices and places orders. This is of equal importance, or even greater than the question of proper specifications and definitions. It certainly offers a wider field for the purchasing agent's imagination and resources, and his authority should be supreme in everything pertaining to this phase of buying.

There are no limitations to the purchasing agent's market, providing he can get the right price and delivery. These two conditions are often governed by geographical considerations, but during the recent strenuous times many buyers have had to go to entirely new markets to secure their requirements. To get the right price there must be the right kind of competition—that is, competition between those firms who are in the best position to supply the goods required. This point is too often ignored and many buyers think that, because they secure a number of quotations for comparative purposes, that is sufficient to insure sound competition. Nothing could be more fallacious, for it is only by a very careful selection of the right firms that the desired results can be obtained. If requests for quotations are sent out in a haphazard manner it is doubtful whether one gets in touch with the people best fitted to supply the material.

Illustrations of this occur daily because sufficient care is not exercised by buyers in selecting their sources of supply. Take a list of concerns handling such commodities as steel, lumber, chemicals, leather, etc., and it will be found that certain of them are in much better position to supply a certain grade than others. This applies also to all kinds of manufactured articles. Take, for instance, bolt and nut manufacturers; some of them make only machine bolts and cold punched nuts, others make finished bolts and milled nuts. Some confine themselves to large sizes and others to small.

These distinctions and refinements are the result of the universal tendency to specialize, which really means more intensive manufacturing and merchandizing. If a purchasing agent goes into the market in a general way and on a hit-or-miss principle he may strike the firm who can best serve him or he may not. There should, however, be no doubt on this point, for, as pointed out in the first part of this article, far-reaching consequences are involved.

A form should be used for collecting and tabulating information regarding sources of supply. Having proof that a firm makes or can supply the exact material he needs, it is then incumbent on the buyer to investigate other features, such as its capacity and output, the location of its factory or shipping point, its method of doing business, reliability, etc. With all of these features favorably determined a purchasing agent can approach all such firms he may have listed with the positive assurance that any quotations he receives will represent sound and reliable competition, and he will know that the orders he places will have proper attention.

This will have been accomplished with the least loss of energy to his own department, the least disturbance to the commercial world and at the least expense to all competitors for his business. These are important economic considerations.

By trading only with those firms who are best equipped to supply him, a purchasing agent not only secures for himself protection against high prices, but the efficiency of his department is greatly enhanced. There will be less follow-up work in getting shipments made at the desired times. Invoices will be rendered promptly, insuring all cash discounts being available. Complaints regarding material will be greatly lessened if not entirely eliminated. Useless and superfluous correspondence on all these points which so frequently encumbers a purchasing department will be avoided.

The information and data necessary in compiling the list of sources of supply can be accumulated from many avenues. There is first one's experiences in the negotiations and transactions taking place daily in the office. A careful survey of the advertising columns of trade papers and periodicals will add many useful names. There are the trade registers and classified directories. In taking names from any of these sources the important point to keep in view is how they fit in with one's own objects. More information than is usually obtained from an advertisement or directory must be secured before they can be deemed eligible for the special lists kept in a purchasing department.

The two points which have been emphasized in this article may be designated as the two main fundamentals of purchasing. The seller has no means of protecting himself from buyers who request prices and information on goods which are ambiguously or incompletely specified, or for goods which he cannot furnish, or is not best fitted to supply. The buyers themselves can improve these conditions and will reap any resulting benefits.

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Further Experiments Upon Wake and Thrust Deduction*

Effect of Variation of Block Coefficient of Model—Variations in Relation to Prismatic Coefficients of After-Body

BY W. J. LUKE

IT has been the pleasing duty of the writer to present to the Institution two papers on this subject, one in 1910,† followed by another in 1914.‡ The first of these contributions dealt with the results of experiments on one particular model, chosen so as to represent, as nearly as could be judged, a mean of current practice; the principal feature of that paper was the section dealing with the variations in value of the hull efficiency elements due to variations in angle bossing. It may be recalled that with twin outward turning screws the adoption of horizontal bossing led to large wake fractions, and that considerable diminution of these wakes resulted from sloping the bossing; the reverse result was reached with inward turning screws. The effect of these variations on the thrust deduction fraction was much less marked. Other results were reported, but were of a distinctly less novel character. The contribution made in 1914 extended these results to the cases of quadruple screws, and also gave results to experiments with screws centrally placed.

It was quite evident that much ground remained to be covered by experiment; for example, changes in proportion of the ship's dimensions might have a perceptible effect on the values of the factors under discussion, but it seemed from the examination of a number of isolated examples that no great variations would probably be found to result. It was known that this was not the case with variations in fullness of form, consequently the present notes have been compiled as complementary to the previous contributions and may perhaps be looked upon as finishing the present writer's contribution to this subject.

As it was expected that the variations in wake values would be tolerably regular, the experiments were first planned for two models, one with a block coefficient of 0.55, and the other of 0.75. They were of the same linear dimensions as the model of 1910, viz:

Length	204
Beam	30
Draft	9

This seemed to promise with that model such a series as would—with a little extrapolation—cover all usual cases. There appeared to be no necessity to multiply experiment, nothing was done with inward turning screws, and it was at first intended to make no variations in propeller dimensions. The 6-inch propellers of the original experiments were made use of, placed just as before, viz.: with a spread between their axes of 10 inches with their centers 1½ inches before the after perpendicular, and with 2-inch immersion. Bossings were fitted at four different angles of inclination, viz.: at 0 degrees, 22½ degrees, 45 degrees and 67½ degrees from the horizontal, and were uniformly ¾ inch thick, rounded on the outer edge and well tapered abaft. In all these details it will be seen that the original data have been entirely followed.

No records of rotative efficiency were taken, as the actual screw efficiency has no especial bearing on these investigations.

Standard speeds of $\frac{V}{\sqrt{L}} = 1.00$ and $\frac{V}{\sqrt{L}} = 0.66$

were adopted for the two models respectively. The curves shown in Fig. 1 represent the results of the experiments

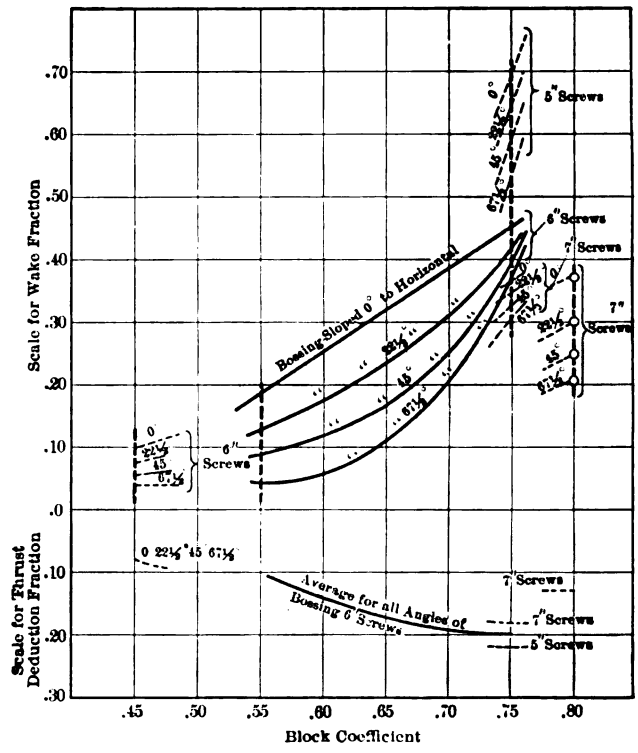

Fig. 1

associated with those previously presented for the model of 0.65 block coefficient, and show that while the results of the finer of the two new models were just about what might have been expected, those for the fuller model were higher than looked for, and showed very moderate variations, due to variations in angle of bossing; in this latter case the experiments were repeated in their entirety and their substantial accuracy was confirmed.

As previous experiments had led to the expectation that the plot of wake values on a basis of fullness would have assumed an approximately rectilinear form, the result was nothing short of disappointing. However, after considering a number of possible reasons for this result, it was at last concluded that although not much influence might have been exerted by the selected relations of length to transverse dimensions, yet for a model of the fullness adopted the relation of width to depth was abnormal, and as a partial result of this the screw was on the small side. Sets of experiments with screws of 5 inches and 7 inches

* Paper read at the Institution of Naval Architects, March 29, 1917.
† Trans. I.N.A., Vol. liii, page 43.
‡ Ibid., Vol. lvi, page 33.

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in diameter were made and thoroughly confirmed this latter conclusion.

To complete, it was therefore decided to make experiments on another model with a proportion of draft to breadth of 0.475 and with 7.5 beams in the length.

The departure from the previous $\frac{\text{Length}}{\text{Breadth}}$ proportion

was made somewhat reluctantly, but upon consideration that the results would probably be but little affected thereby, and as there was a pressing reason for time economy when the experiments were made, this variation from precedent was accepted.

The draft of the new full model thus became 12.9 inches; and in the experiments screws of 7-inch diameter were adopted, with a tip immersion of 4 inches. The results of these experiments were fairly harmonious with preconceived ideas; and serve to show (with full ships at least) what wide variations may result from unsuspected causes.

Opportunity also offered to run a few experiments with a model of as low a block coefficient as 0.45; here, again, the proportions are not quite those adopted as standard. The speed adopted was

$$\frac{V}{\sqrt{L}} = 1.33,$$

and the results are shown for comparison.

It is of great importance here to note that these values will not apply to vessels of excessively high speed in relation to size; although as regards fullness of form they come within the range dealt with in this communication. Torpedo-boat destroyers and other light craft, whose speeds are pushed up to values of

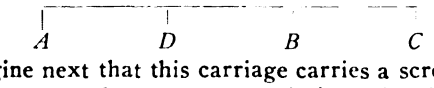
$$\frac{V}{\sqrt{L}} = 2$$

and beyond, seem to have reached an order of circumstance different in character. Taylor has pointed out that increase in fullness for the same length and displacement gives rise to diminution in resistance, and analysis at least shows that the wake has a negative value. It must, therefore, be carefully borne in mind that the results here presented are not applicable to vessels of this type.

So far, only wake has been mentioned, as it is that factor of the hull efficiency which seems to be subject to the greatest amount of variation. It will suffice to note merely that the thrust deduction values are exhibited in the companion curve, and really call for no special remark.

It may be asked, What is the purpose of all this investigation? The answer is, that it is essential to assess fairly the elements of a propeller in the stage of design, and is by no means for the purpose of showing where a propeller is to be placed so as to get the "maximum return from the wake current." For the purpose of making this clear, it will be well to repeat a paragraph from the communication of 1910. The method of experiment and the subject of experiment were thus described:

"It may be imagined that a traveling carriage can be made to run over a body of water, and at a speed that can be diagrammatically represented by $A\ B$.



"Imagine next that this carriage carries a screw propeller made to revolve at such revolutions that if working without slip its speed of advance would be $A\ C$. Then $B\ C$ is the slip, and

$$\frac{B\,C}{A\,C}$$

the slip as ordinarily expressed as a fraction of the propeller speed, or as a percentage by being increased a hundredfold. The conditions under which such a propeller is working are described by the word 'open,' and are not the same as those in which a propeller works when propelling a ship.

"The ship in its onward path is followed by a belt of water of complex motion, and if (over the propeller disk) it can be assumed that its average forward velocity is $D\ B$, the propeller is carried along at the former speed over the ground, and, being revolved as before, would behave in

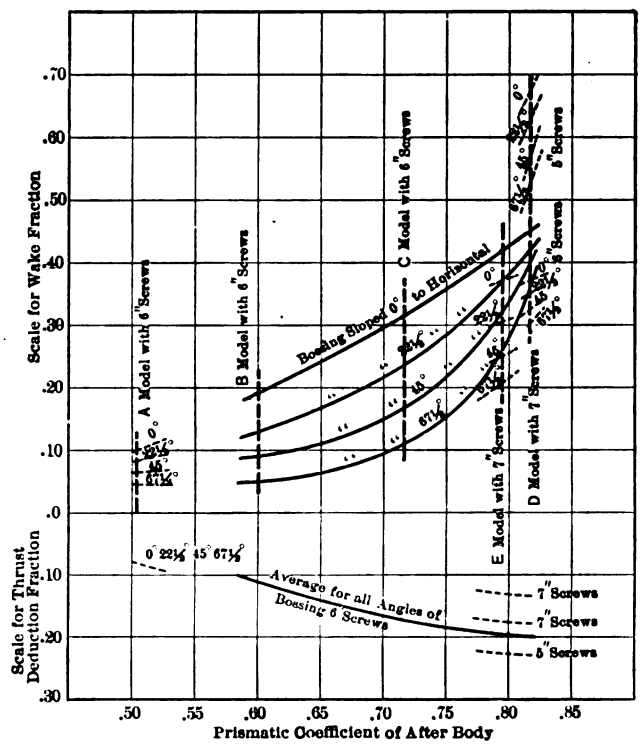


Fig. 2

some respects as would an 'open' propeller advancing with a speed $A\ D$ and with a slip $D\ C$.

"The wake velocity, as before stated, is $D\ B$.

"The wake fraction w is

$$\frac{D\,B}{A\,D},$$

as in Froude's original nomenclature.

"The apparent slip is $B\ C$, and the apparent slip ratio

$$\frac{B\,C}{A\,C}.$$

"The real slip is D C, and the real slip ratio

$$\frac{D\,C}{A\,C}.$$

"The thrust is appropriate to the speed of advance $A\ D$ and a slip $D\ C$.

"The thrust, however, is being overcome at a velocity $A\ B$, and the apparent work is thrust $\times\ A\ B$, instead of, as with an 'open' screw, thrust $\times\ A\ D$, and under such circumstances the work 'behind' shows an excess over that obtained in the 'open' in the ratio

$$\frac{A\,B}{A\,D},$$

the excess over unity being the 'wake gain.'"

So that the factor in the hull efficiency which denotes

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"wake gain" has already been exactly allowed for in a corresponding deduction in the suppositious speed by which the thrust advances. There is, in fact, no such wake gain, though the idea recurs from time to time.

It was pointed out by Mr. Baker* that wakes might be more satisfactorily dealt with by considering their variations in relation to the prismatic coefficients of the after-body. Fig. 2 shows the results plotted on this base. It is certainly more regular in form than the graph on a base of block coefficient of the whole form, and consequently it might be well, in accumulating data, to follow this line. It calls for no further remark in this connection.

A most important use to which the sum total of the information available on this subject can be put is in its application to the results of trials. A trial carefully conducted results in records being obtained of horsepower, speed and revolutions of propellers;

TABLE I—WAKE AND THRUST DEDUCTION

Particulars of Models

Model	δ	M	B	D	ϕf	ϕa	β
A	0.45	7.25	0.967	0.319	0.542	0.504	0.860
B	0.55	6.45	0.968	0.290	0.540	0.600	0.965
C	0.65	6.20	0.910	0.275	0.627	0.719	0.965
D	0.75	5.82	0.873	0.262	0.734	0.820	0.965
E	0.80	5.29	0.705	0.335	0.820	0.796	0.990

Where δ = block coefficient,
ϕf = prismatic coefficient—fore body,
ϕa = prismatic coefficient—aft body,
β = mid area coefficient,

$$M = \frac{L}{\Delta^{1/3}} \times 0.3057, \text{ or } \frac{\text{length}}{U},$$

$$B = \frac{\text{breadth}}{U},$$

$$D = \frac{\text{draft}}{U}.$$

TABLE II—WAKE AND THRUST DEDUCTION

Comparison of Wake Values Obtained by Analysis from Taylor's 1904 (Three-Bladed) Propeller Curves and Those Obtained from Fig. 3

Case	δ	Angle of Bossing	Trial Analysis Wake	From Wake Curves
		degrees		
Twin-screw cargo ship....	0.725	25	0.29	0.28
" yacht	0.532	30	0.09	0.14
" cross-Channel steamer	0.481	38	0.10	0.09
" cruiser	0.518	—	0.12	0.12
" cross-Channel steamer	0.498	15	0.16	0.14
" cruiser	0.521	—	0.10	0.12
" liner	0.710	14	0.32	0.30
" cruiser	0.534	—	0.14	0.13
" cruiser	0.510	—	0.07	0.11
" cross-Channel steamer	0.500	20	0.12	0.13

and probably also some idea of the efficiency of the result achieved; at least whether the result is good, indifferent, or disappointing, even if the resistance of the ship, as derived from model experiments, is not known. These data furnish the only records from the ship and machinery from which an estimate of the various causes contributing to the efficiency of the whole installation can be assessed. One very important feature is the efficiency of the propeller, which in turn is largely bound up with the slip at which it is working; and before the real slip as distinct from apparent slip can be determined, some approximation to the wake must be made.

There is no doubt that when any large collection of data has been got together it must be carefully analyzed in order that the information contained in it can be made generally available; failing this, departure in a design from some previous example in any material degree can be nothing more than a leap in the dark.

For the purpose of the analysis here mentioned some scheme of model propeller experimental results is also necessary, and there exists a choice of four or five different sets. These all differ from each other, not fundamentally, it is true, but sufficiently so to suggest that, wherever practicable, one and only one set of curves should be used when a number of different results are being analyzed. With them it may also be found that the absolute figures for wake and thrust deduction may not hold

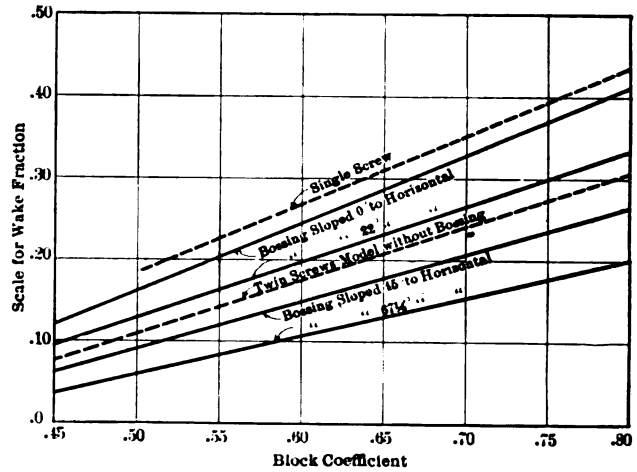

Fig. 3

just as they have been published; but at least it may be hoped that comparatively the results may be found to be useful to those who are engaged in the pursuits of naval architecture and marine engineering.

The whole comparable data on wake presented in my three papers are collected in Fig. 3, which may fairly well suffice for design purposes. The results of analysis of the speed trials in ten different cases, indiscriminately chosen, will serve to show what variations may exist between experimental data and the probabilities of actual facts.

In conclusion, it must be mentioned that this and previous papers could not have been presented to the Institution without the hearty co-operation and indefatigable work of the staff at the experimental tank of Messrs. John Brown & Co., Ltd., Clydebank, to whom my best thanks are due.

WOODEN SHIPS IN DENMARK.—The building of wooden vessels is now well under way in Denmark, and although the start is small, the experiment will be pushed, according to reports from Consul General E. D. Winslow at Copenhagen. The decision in this matter has been hastened by the submarine warfare of Germany. At many ports in Denmark temporary arrangements have been made for the laying down of wooden ships. Many industries are threatened with stoppage, due to the lack of raw materials, and the workers can thus be given employment at the shipyards building these vessels. The vessels are auxiliary sailing vessels of a standard type, having a loading capacity of 500 to 600 tons.

* Trans. I. N. A., Vol. liii, p. 94.

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Experiments on the Influence of Running Balance of Propellers on the Vibration of Ships*

Dynamic Balancing of Propellers Necessary to Effect Perfect Running Balance—Instrument Devised to Record Vibrations in Ship Due to Propellers

BY J. J. KING-SALTER, R. C. N. C.

The vibration of ships has been the subject of many papers and much discussion, but, so far as the author's knowledge goes, it does not appear that the particular question of the action of the propellers themselves, in so far as the effect of their running balance has upon vibrations, has been previously brought forward. Since the introduction of turbines in warships as the main engines, running at much higher revolutions than was previously the case with reciprocating engines, the necessity of seeing that the propellers were suitable, not only as regards their form, but also as regards their being in proper mechanical balance, has naturally received more attention.

The object of the present notes is to present the results of some experiments on this point carried out by the author in the course of his work as general manager of the Commonwealth Naval Dockyard at Sydney, Australia, and which the Australian Naval Board has granted him permission to submit to this institution. The experiments to which reference will be made were carried out in two destroyers and a Town class cruiser, which were being built at the Commonwealth Naval Dockyard. In the case of the destroyers, it may be of interest to observe that the turbine engines and the propellers were the first of their kind to be built in Australia, and that, consequently, every care was taken that they should be as perfect as possible.

On test in the shops, under steam, the turbines ran as free from vibration as any one could wish or expect, spe-

* Read at the Spring Meetings of the Fifty-eighth Session of the Institution of Naval Architects, London, March 29, 1917.

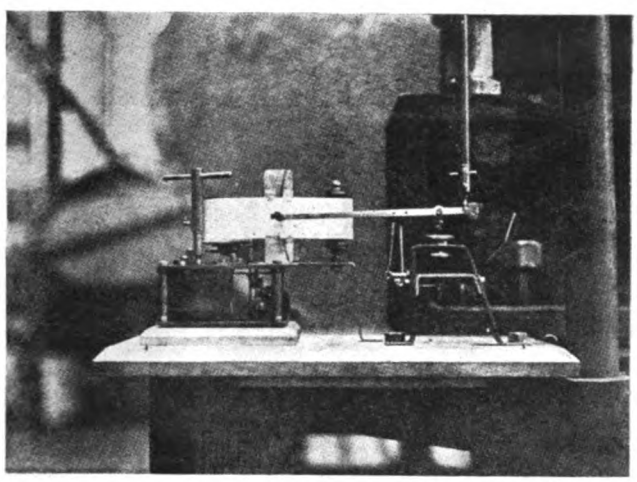

Fig. 1.—Instrument for Recording Vibrations

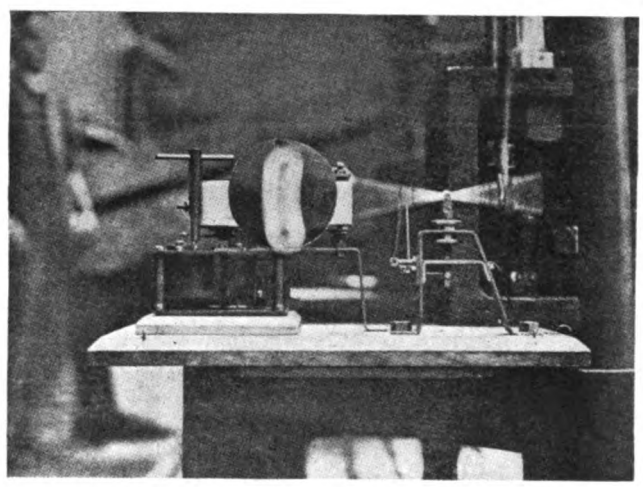

Fig. 2.—Recording Instrument in Operation

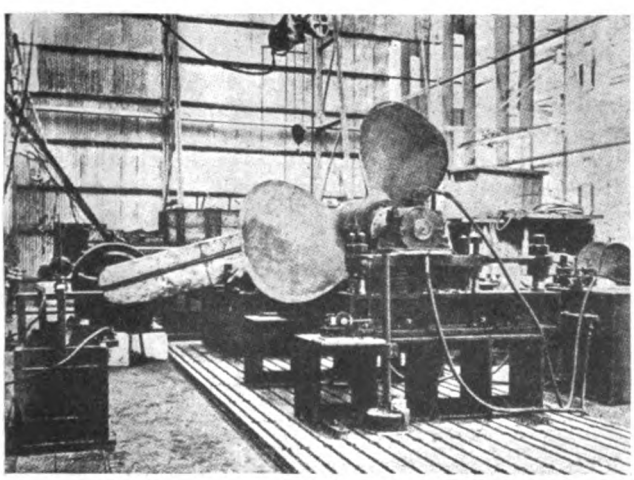

Fig. 3.—Apparatus Used for Dynamically Balancing Propellers

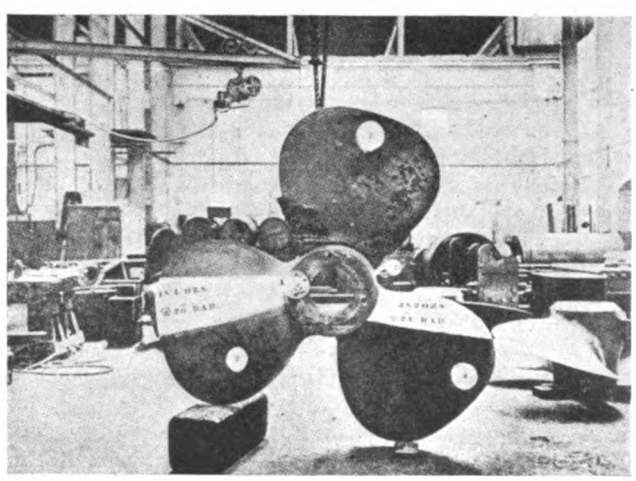

Fig. 4.—Cruiser Propeller with its Balancing Weights

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cial care having been taken in their manufacture to insure the rotors being in as perfect running balance as possible, the means adopted to do this being first to balance each rotor on knife-edges to obtain a static balance, and subsequently to mount it on spring bearings, so arranged that the rotor in its bearings was free to move up and down vertically, but not sideways, and then rotating the rotor in its bearings at speed, and by removing weight at the end as found necessary till the rotor ran in its spring-mounted bearings without a perceptible tremor, thus insuring what may be called dynamical balance. No claim is made for any novelty in these methods as regards the rotors, but it is mentioned on account of what follows in regard to the subject matter of this paper.

The usual and most recent practice as regards the manufacture of the propellers for the destroyers was followed, viz.: After being cast, the driving faces were machined to true helics, and the backs chipped and filed to insure as uniform and as accurate a shape as possible, sections being carefully calibrated at frequent radii and made to agree with the designed thickness at each point of calibration, and then statically balanced on knife edges, not between lathe centers, as it was considered and found that knife edges were more sensitive; and, finally, the whole surfaces were buffed to a smooth polish.

The first destroyer to be completed with the Australian-built engines and propellers, made as described above, ran her trials very satisfactorily, but there was a certain amount of small vibration in the vessel, most pronounced right aft above the propellers, of which there were three—one on each of three shafts. The vibration extended right through the vessel, very much diminished forward, but sufficient to cause the hand rails and other fittings in the engine room and fore bridge to shake, being more pronounced on the fore bridge.

Tracing the Source of Vibration

That this vibration was due to the main engines was considered most improbable, as these latter apparently ran as smoothly and as free from vibration as they did in the shop test. The other only rotating masses that could possibly be supposed to cause vibration were the propellers. Was this vibration due to the propellers working in the water with possible interference with each other, and other water causes, or was any of it due to the propellers themselves not being in perfect running balance?

The question then arose, were the propellers, as manufactured, fulfilling the conditions for perfect running balance which, quoting from Mr. Barnaby's book on "Marine Propellers," are given to be:

(1) Each blade must be of the same weight.

(2) The center of gravity of each blade must be at equal distance from the axis of the propeller.

(3) The center of gravity of each blade must lie in a plane at right angles to the axis.

To fulfill these conditions, each part of each blade must be exactly the same shape, the same thickness, and be symmetrically situated around the axis. If this is so, then condition (3) insures that each blade is similarly placed along the axis.

There is no way known to the author for conditions (1) and (2) to be obtained, except by care in casting, marking off, and machining the driving faces, hand chipping and filing the backs, and calibrating sections at frequent intervals to given dimensions. If this was carried out exactly, condition (3) would be naturally satisfied. But in practice it is practically impossible to insure that all parts of each blade shall be exactly of the same thickness, and that all parts of the propeller are exactly and symmetrically disposed around and along the axis.

What check can there, therefore, be exercised to know whether condition (1) or (2) is satisfied, as it is possible for the propeller to be in static balance, and yet for these two conditions not to be fulfilled, and, so far as the author's knowledge goes, he does not see what other method can be adopted to place an absolute check on these two conditions. And, as regards condition (3), hitherto, also, so far as the author knows, no other check other than the static balance and the calibration has been exercised to prove whether this condition has been fulfilled, and it has apparently been assumed that the above checks have been satisfactory.

Dynamic Balancing of Propellers

The object of this paper is to show that there is another check to which propellers can be subjected, viz., dynamic balancing, i. e., the rotating of the propeller at speed on spring bearings, noting the vibration, and the removal of weight from certain parts of the blades and even the boss, the position of which is indicated by the direction in which the vibration acts, in a manner exactly similar to the way in which a turbine rotor is balanced, as mentioned above. It is contended that by this further balance a perfect running balance can be obtained, i. e., one in which the propeller can be made to rotate at any speed in the spring bearings without a perceptible tremor, and presumably, if it will do this in a live bearing, it will similarly run without vibration on its shaft in the ship. Condition (3) is thus satisfied, and also that the mass center of the propeller coincides with center of rotation, but it does not in any way help to satisfy conditions (1) and (2), and, as previously stated, so far as it can be seen, the approximate satisfaction of these two first conditions can only be obtained by careful and accurate workmanship.

As previously stated, if conditions (1) and (2) were exactly fulfilled, and the propeller otherwise also accurately made, condition (3) would follow; but that it does not has been proved by the tests carried out, every propeller so far tested—some twenty-five have been dynamically balanced—not one was without considerable vibration. Some of these propellers were made at the Commonwealth Naval Dockyard, and others have been supplied by various contractors, all of which latter were built under Admiralty supervision and conditions, so that it may not be far wrong to assert that there is probably hardly a propeller made which, if subjected to the dynamical balancing test, would not be subject to vibration.

It is thought that a little consideration will show that this is probably the case, as it is practically impossible to insure that every part of each propeller is exactly symmetrical, when such accuracy depends so largely on hand work to measurements; and, moreover, there is the added possibility of a difference in density in the material, and also the great difficulty at the roots of the blades and at the boss of insuring absolute uniformity, but, by utilizing the centrifugal forces developed when the propeller is rotated, all these discrepancies at once manifest themselves, and with a little care and experience they can be practically entirely eliminated.

It might be supposed that, in the short fore and aft length, such as the average propeller has, the magnitude of the forces about the plane at right angles to the axis would not be great enough to cause much vibration, and that it would not appreciably affect the ship, but the result of the experiments carried out, referred to below, in two destroyers and one larger vessel—a Town class cruiser—show that they do have a very considerable effect. That

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this may be so will be readily understood, when it is remembered how great are the forces developed by small weights under centrifugal forces, acting at the speeds turbine-driven propellers have hitherto been run.

It is well known to be unnecessary for running balance, that any number of weights, disposed rigidly around a shaft, shall be of equal weight, nor that their centers of gravity shall be at equal distance from the axis of rotation, but such a system will only rotate in dynamic balance when condition (3) is fulfilled. The conditions for such balance may be found in treatises on statics and dynamics, but reference is specially made to a book by Professor Dalby on "The Balancing of Engines," 1902, page 13 *et seq.* It may be of interest to note the importance attached to the practice of balancing railway carriage wheels referred to in Professor Dalby's book (*vide* page 19), which balancing is practically the same as here proposed for propellers.

The dynamical balance does not, therefore, provide a perfectly balanced propeller, as defined by Mr. Barnaby, but it does provide for one that will rotate without vibration if the balancing is properly carried out. Clearly, if a propeller will vibrate when tested in the shop, such vibration must be transmitted to the ship.

All the propellers hitherto dynamically balanced by the author have been those which had been completed and passed as satisfactory, but in future, in making new propellers, it is proposed, after the shaping of the blades and calibration have been completed, to dispense with the statical balancing, and proceed with the dynamical balance straight away, as the tests carried out in that balance would show whether the out of balance was due to the mass center being eccentric, or whether it was due to condition (3) not being fulfilled. Once the balancing apparatus is provided, it can be safely asserted that the time and cost required to build a propeller will not only be less, but the result will be far more satisfactory, as hitherto the time taken to balance a propeller on the knife edges has been considerable.

Effect on Ship of Eliminating Vibration in Propellers

The next point to determine was how much would elimination of vibration in the propeller affect the ship. To do this it was necessary to have an instrument that would record the small, quick vibrations, but take no account of any of the pitching and rolling motions of the vessel when in a seaway.

At the time the first set of dynamically balanced propellers was tried in one of the destroyers, the author, unfortunately, had no instrument available which would do what was required. A Schlick vibrometer was tried, but in these light vessels, and in an open seaway—no smooth water being available—this instrument, when adjusted sensitively enough to record the small vibrations, was so affected by the pitching that no satisfactory results could be obtained. It can only, therefore, be asserted that in the opinion of the ship's and Dockyard officers—and of the author's—there was a decided improvement. The shaking of the hand rails in the engine room and on the fittings on the bridge had been practically eliminated, and the vibrations aft were considerably reduced.

The author would not have attempted to put forward these remarks had he not something more definite to rely upon than personal opinion, and it was in the subsequent experiments on the Town class cruiser, which was being built at the Dockyard, that he was able to obtain a permanent record of the difference in vibration between two sets of propellers, as made by one of the leading specialist manufacturers of propellers in England, the one set being tried on the ship as supplied by the makers, and the other after being dynamically balanced by ourselves. By the time this vessel was ready for her trials the author had, after much consideration, evolved a very simple means of obtaining a definite record by an instrument which, although it did not give absolute readings of the vibration of any one particular part of the ship, yet gave definite differential readings of the vibration of two parts, which were readily comparable under the two conditions, and which were, for the purpose required, entirely free from the effect of the vessel's movements in a seaway. The principle of the instrument depended upon recording the difference of vibration of two decks, one immediately over the other. It was anticipated each deck would, owing to their different stiffnesses, have a different amplitude of vibration, and that if stiff rods were fixed one to one deck, and the other to the deck over, and pointing to meet one another, and slide over one another at their junction, the relative movements of the two rods, repeating the movements of

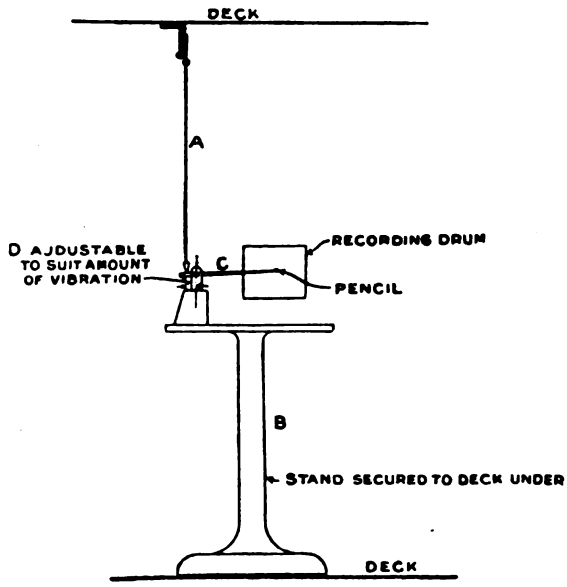

Fig. 5.—Diagram of Recording Instrument

the decks, could, by means of a simple lever, be magnified and recorded on a drum worked by clockwork.

A diagrammatic picture of the principle of the arrangement is shown in Fig. 5; and Fig. 1 is a photograph of the actual instrument.

Referring to Fig. 5, the two rods are represented by the rod *A*, and the standard *B*, both of which move with their respective decks, being secured thereto. The multiplying lever is shown at *C*, and the recording drum, worked by clockwork, is seen under the end of the lever *C*. It was, however, a matter for conjecture as to what would be the amplitude of the vibration to be recorded. The leverage of the recording lever was, accordingly, made adjustable, so that multiplication of the actual movements of the decks could be varied from 50 to 1 to about 5 to 1, by adjusting the length *D*. It was found that the ratio of 25 to 1 gave good readings, and was sufficiently sensitive to show the smallest vibrations. A speed of paper of about 30 inches per minute was also found suitable.

The instrument was put up in the captain's cabin, approximately over the aftermost pair of propellers, of which there were four, one on each of four shafts. The deck over was the upper or weather deck, and the deck under was the protective deck. This latter deck was, by

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the nature of its structure, very stiff, and, by its position nearer the neutral axis, less liable to vibration than the upper deck. The instrument recorded, therefore, only the relative movements of these two decks, so that readings of the vibrometer would tend to be either more or less than the real movement of either deck, according to their relative motions.

The readings might be the sum of the movements of the two decks, or their difference, but this did not, it is considered, impair the results aimed at, viz., to obtain relative records between vibrations set up by the two sets of propellers—the one only statically and the other also dynamically balanced.

The trials of this vessel were being carried out with a view to completing her as soon as possible, and, being under war conditions, no time was available to make special sea trials, but such results as were obtained were sufficient is not unreasonable to assume that some of this increase was due to the propellers working under better balance, and, if this was so, a small increase of speed would result, as when a set of propellers, each weighing nearly two tons, even in such a comparatively small vessel as the one in question, are sufficiently out of balance as to vibrate considerably when tested in the shop in the spring bearings before being balanced, and when such propellers are working in the ship, setting up vibration, it is very evident that such vibration not only must cause extra friction in the *A* bracket bearings, and thus tend to reduce the revolutions and general efficiency of the propellers, but must also increase the wear and tear in those bearings, and also in other fittings in the ship generally.

The rates of revolutions given on the records are the mean of the four shafts. The variation from the mean at 493 revolutions amounted to about 15 above and 15 below.

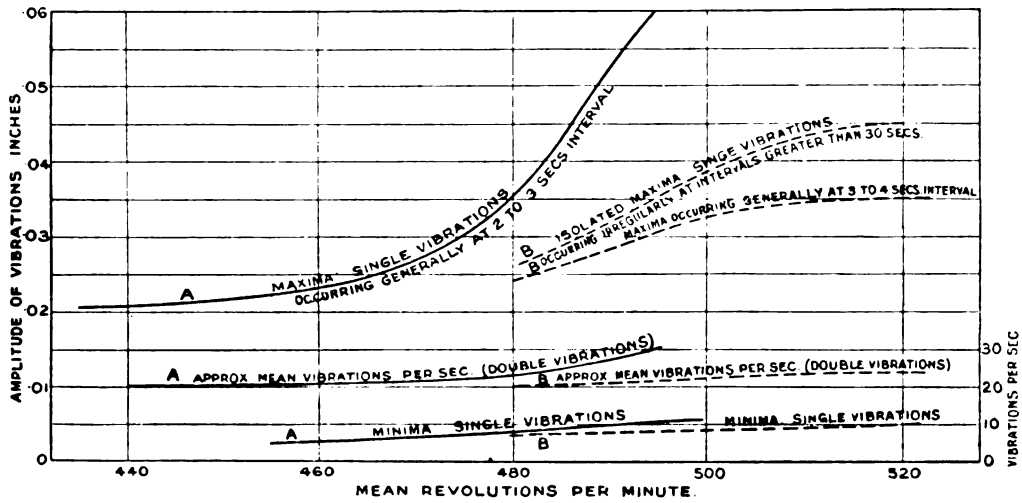

Fig. 6.—Vibrometer Records, Vessel Fitted with Four Propellers. Curves A—Propellers Statically Balanced, Taken on 25,000 and 22,000 Shaft Horsepower, Trials 4-11-16. Curves B—Propellers Statically and Dynamically Balanced, Taken on Commissioning Trials 4-12-16

to show the very marked difference between the two sets of propellers.

In order that the conditions for vibration might be the same, the loading of the vessel in the two conditions was maintained as similar as possible, so that the drafts were practically the same. Fig. 6 shows the curves deduced from the records obtained.

In Fig. 6 the upper curve *A* shows the maximum readings obtained with the unbalanced propellers. It will be observed how, at the highest speeds reached, viz., about 493 revolutions, the vibrations increased at a rapid rate, whereas in the upper curves *B B* the maxima were not only much less but of a different character. In the *A* curves periods of relatively intense vibration, alternating with periods of comparative small vibration, occurred at frequent but varying intervals, whereas in the curve *B* these periods of intense vibration had become so much reduced as to be almost absent, occurring only at long intervals.

The periods of intense vibration felt to the observer quite severe, and were sufficient to cause any objects lying on the cabin table to rapidly dance off, whereas with the balanced propellers, such objects remained on the table. It may be of interest to observe how very small the total amplitude of vibrations really were, *vide* Fig. 6.

It will be noticed that the maximum revolutions with the balanced propellers were higher than with the unbalanced. The greater part of this increase was no doubt due to the stokehold party providing more steam, but it This in itself is a probable source of vibration. It will be noticed that the rate of the vibrations recorded increased slightly as the speed increased, and at the higher speeds was about twenty-five per second, whereas the maximum of each propeller on test in the shop was about ten per second.

It will, it is considered, be admitted that the impressions and assertions of so many persons in the case of the destroyers, and the evidence of the records obtained in the case of the cruiser, cannot be a mere coincidence, and if the author has succeeded in showing that to obtain the best results and to effect perfect running balance it is necessary dynamically to balance propellers, and, so far as he can see, that such balance is unobtainable otherwise, he will rest satisfied, observing, in a time like the present, when our navy is undergoing such a severe ordeal and when our ships are running so constantly at full speed, that anything that can be done to reduce vibration must help considerably to reduce the fatigue of the officers and men, who are now being strained to their uttermost limits. As the author can safely say, he would personally have been very sorry to have had to live in the captain's cabin when steaming at full speed with the unbalanced propellers, whereas with the others, although there was still not an inconsiderable amount of noise and vibration, yet the two conditions were so totally different, one of the officers of the ship, without stopping to think, exclaimed: "It is quite 100 percent better," and the author can only say he wished it had been so perfect.

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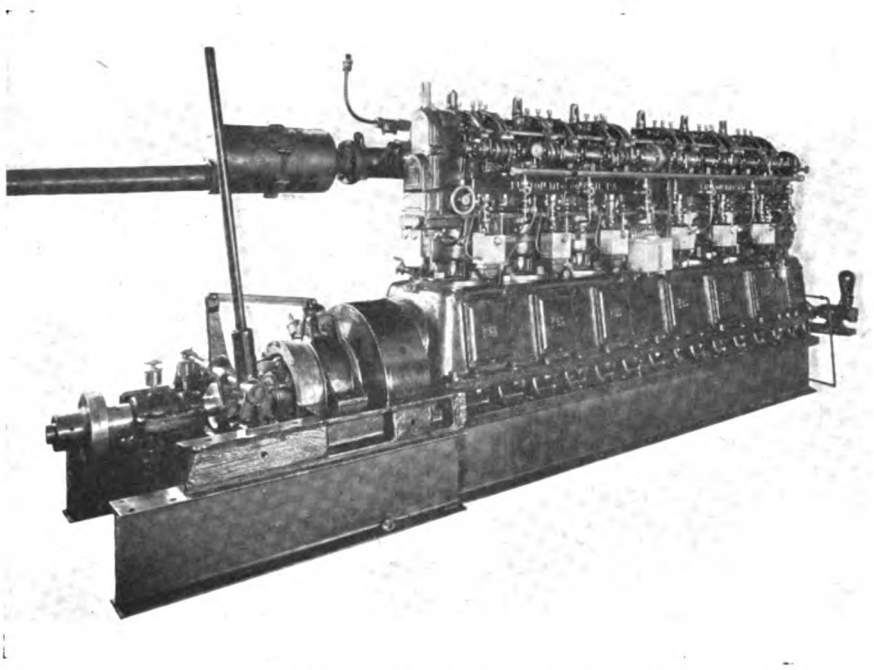

Fig. 1.—Fulton Marine Diesel Engine of 100 Horsepower

Diesel Engine of One Hundred Horsepower

Built by Fulton Manufacturing Company, Erie, Pa. for War Department—Installed in 50-Foot Tender Serving Government Dredges

WHAT is believed to be the smallest oil engine of the straight Diesel type of pure American design and workmanship that has so far been installed in the United States is the 100 horsepower Fulton Diesel engine installed in a 50-foot wooden tender built by the Charles P. Willard Company, Winthrop Harbor, Ill., for the Engineer Corps of the War Department. The boat is being used in connection with river and harbor improvement work on the coast of North Carolina, with Wilmington, N. C., as headquarters. In this work the dredges are sometimes 40 miles from the railroad and the small tender is used for towing water and provision barges to the dredges, moving anchors, etc. The work is particularly arduous and trying on both boat and engine because of the character of the coast. The water is shallow and muddy, and the shallow water easily kicks up into a choppy sea.

The *Manteo,* as the boat is called, is 50 feet long overall by 13 feet beam, 6 feet 6 inches depth of hull and draws 4 feet of water loaded. The engine is a four-cycle, six-cylinder Fulton oil engine of the straight Diesel type, built by the Fulton Manufacturing Company, Erie, Pa. The cylinders are 8 inches by 9 inches, and at a speed of 400 revolutions per minute the engine develops 100 brake horsepower.

Results of Government Tests

Tests of the engine made by the War Department included a preliminary test at full speed for forty-five minutes, and then on the following day a series of tests at varying speeds. The first test was at 322 revolutions per minute, the second at 273 revolutions per minute, the third at 231 revolutions per minute and the fourth at 400 revolutions per minute. The first three runs were for a period of one hour each and the fourth for a period of two hours. In these tests the brake horsepower and fuel consumption were determined. At 400 revolutions per minute the engine developed 100 brake horsepower and consumed 0.53-pound of fuel oil per brake horsepower hour. No difficulty was encountered in readily starting the engine, which ran smoothly and without missing fire throughout the test. The exhaust was clear and without odor. The air pressure for starting the engine and for fuel injection varied from 750 pounds per square inch at low speed to 1,125 pounds per square inch at high speed.

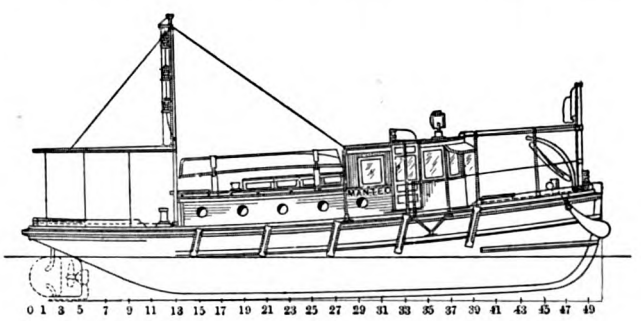

Fig. 2.—50-Foot Tender *Manteo*

Fuel oil is fed to the engine by gravity from a 50-gallon tank located directly over the engine. An oil pump in the engine proper pumps the oil from the main oil tanks, which are forward of the engine room and under the pilot house, up into this gravity tank. A return pipe to the main tanks makes it possible for the pump to be in continuous operation, the surplus oil being carried back to the tanks. Situated below the gravity tank is a 2-inch pipe in which is a glass gage with a pet cock at the bottom. Any water or dirt will settle in this pipe and can be seen

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through the glass and drained off through the pet cock.

As shown in the photograph, Fig. 1, the two-stage air compressor is situated at the forward end of the crank case. From this compressed air is led through a water-jacketed pipe to three steel air bottles tested to a pressure of 3,000 pounds per square inch. The air in one of these bottles is used for the injection of the fuel. As the compressor compresses more air than is required for injecting the fuel while the engine is in operation, the surplus air is stored in the two other steel bottles and is used for starting only. While it is supposed to be very difficult to hold the air at such high pressure, it has been found, on the contrary, that if the valves are properly seated no difficulty will be encountered. As a matter of fact, the air in one of these bottles was maintained at a pressure of 11,000 pounds per square inch for over one month with no appreciable depreciation.

Fuel Pumps and Lubrication

On the starboard side of the engine are the individual fuel pumps, one being provided for each cylinder, so that if by any chance one of the pumps or one of the cylinders fails while the boat is at sea the operator can cut out this one cylinder and continue running the engine with the other cylinders.

Lubrication of the pistons and cylinder walls is by means of a Bosch oiler with two leads to each cylinder. Inside the forward end of the crank case are two rotating pumps, one driving the oil at a pressure up to 15 pounds through the hollow crank shaft and up through the hollow connecting rods to the wristpin bearings. The oil oozes out on the bearings and drops back into the base, which is water-cooled, thus cooling the oil. The oil then passes through a strainer and is returned to the pump. In this way there is a steady flow of cool oil in the bearings, thereby reducing the consumption oil to a minimum, only about 4 quarts of oil being required for a continuous ten-hour run of the engine.

At the forward end of the engine are two heavy bronze plunger pumps for circulating the water and for the bilge system. These pumps are also duplicates, so that if by any chance the water-circulating pump should go wrong when the boat is at sea the operator can immediately connect up the bilge pump with the circulating system and continue running the engine.

Another interesting feature is the fact that the flywheel, instead of being at the forward end of the engine, is at the after end. In this way unnecessary strain is taken off the flywheel. Just back of the flywheel is a Paragon reverse gear.

Propeller

The propeller is a three-blade, style "I," Columbian propeller, 42 inches in diameter by 38 inches pitch, designed to turn at 400 revolutions per minute. As the *Manteo* is a Government vessel, extra heavy stuffing boxes are used on the propeller shaft, each weighing 195 pounds. The bronze shaft is 3½ inches diameter by 13 feet long and weighs 492 pounds.

As economy is a chief point of advantage in a Diesel engine, the following comparison will be of interest. The 100 horsepower Diesel engine installed in the *Manteo* consumes about 6¼ gallons of fuel oil per hour. At 6 cents (0/3) per gallon this would cost 37½ cents (1/6¼) per hour. If the boat is run for three hundred days at ten hours each, the fuel bill would be $1,125 (£230). On the other hand, if a 100 horsepower gasoline (petrol) engine were run a similar length of time, burning gasoline at 24 cents (1/0) a gallon, the fuel bill would be about $9,000 (£1,845). In this case, therefore, the Diesel engine represents a fuel saving in one year of $7,875 (£1,615).

Another remarkable comparison in fuel economy is that of a 70 horsepower Diesel engine which the Fulton Manufacturing Company installed at Sama, Cuba, in a tug owned by the Atlantic Fruit Company, of New York. During the season preceding the purchase of the Fulton Diesel engine, Mr. Middleton, the local manager, was using two gasoline (petrol) engines, totaling about 55 horsepower. His bill for the season for gasoline (petrol) was $2,000 (£410). For the next season, with the Fulton 70 horsepower Diesel engine, the fuel bill was only $130 (£26.6), making a saving to the company in one season of about nine months of $1,870 (£283.4). The vessel on which this engine was installed was a tug used for towing a barge loaded with bananas.

Texas Company's Fleet of Tankers Completed by the Fore River Shipbuilding Corporation

The S. S. *Virginia*, the last of a fleet of four oil tank steamers constructed by the Fore River Shipbuilding Corporation, Quincy, Mass., for the Texas Steamship Company of New York, was recently completed. Two of the fleet, the *Texas* and the *New York*, were completed last year, and are now in service, while the *Pennsylvania* was completed this year. The *Virginia* has two continuous steel decks, a raised forecastle, open bridge, and poop decks, with a lower deck in the package freight hold forward. The hold is divided by oil-tight bulkheads into sixteen main oil cargo tanks, sixteen summer tanks, fuel oil tanks, two pump rooms and a cargo hold, machinery space aft, deep trimming tanks, both forward and aft, and a double bottom under the engine and boilers.

The length over all is 432 feet, and the dead-weight carrying capacity 9,100 tons. The capacity of the main cargo oil tanks is 67,930 barrels, and of the summer tanks 8,634 barrels. Her fuel oil capacity is 10,450 barrels.

The *Virginia* has been designed to carry various grades of refined oil without danger of mixture. The cargo pumping system has, therefore, been worked out to an unusually high point of efficiency, necessitating the use of twelve pumps—eight for the cargo in the main tanks and four for handling the oil in the summer tanks.

The vessel is propelled by a single screw driven by a three-cylinder, triple-expansion engine, steam being supplied by three single-ended Scotch boilers. These boilers are oil-fired on the White atomizing oil-burning system.

The accommodations of the officers and crew are unusually complete.

A Clipper Ship of 1853

(*Concluded from page* 379.)

Ceiling, from bilge to lower deck, 15 inches, scraped and bolted edgewise.

"She has three full decks, securely fastened with fore and aft knees; the hanging knees are extra fastened, having in the lower hanging knees 18 bolts, 1¼-inch iron; middle deck, 20 bolts; also upper deck hanging knees, 20 bolts and all of oak. Beams in lower deck, 14 by 16; in middle deck, 15 by 17; in upper deck, 12 by 16, and some 12 by 20 inches.

"Lower deck main hatch is 14 by 20; middle deck, 14 by 16, and main deck 14 by 11.

"She has a hurricane deck over all, merely for working

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the ship, thereby obviating the difficulty in obstructions from houses, spare spars, water casks, etc.

"Her mainmast is 126 feet long, 98 feet above deck; diameter, 44 inches; masts made of hard pine, to carry two stationary yards with trusses, the same as used on lower yards; fore and main deck alike, and those on the mizzenmast the same as those on the other masts above the lower yards, so that, except the courses, all her sails will have duplicates on every yard fore and aft. Her main yard is 110 feet long, the others in proportion; she will have a fourth mast, principally to lead the mizzen braces, to prevent the difficulty arising from mizzen braces leading forward and hauling the mast out of place.

"The model of the ship was said to promise a combination of swiftness, buoyancy and beauty that has never been excelled. Notwithstanding her vast size, such is her length and buoyancy that, when loaded ready for sea, her draft of water will not exceed 23 feet, a common draft for ships half her size."

Unfortunately, Sir Joseph Whitworth omits the names both of the vessel and her builders, and more detailed particulars might have been given. However, upon the evidence of Frank T. Bullen and others the United States turned out at about the middle of last century the finest and fastest clipper ships ever built. It is hoped that the present activity in an industry so long decayed lends a present interest to the extract given above.

London. A. L. HAAS.

Mission of the Gyroscope in the Marine Field

BY ALBERT W. STRINGHAM*

ONE of the earliest investigators of the gyroscope was Edward Sang, of Edinburgh, Scotland, who in 1836 announced that he had discovered certain gyroscopic principles but was unable convincingly to demonstrate them owing to his crude apparatus. Credit is due Leon Foucault, a French physicist, for the first demonstration of the gyroscope's phenomena. It was, however, left to the well-known American author, Hopkins, of the *Scientific American* (1876), first to apply an electric motor to apparatus similar to Foucault's, and with this device Hopkins was enabled to obtain much more definite and persistent results.

While the gyroscope of Hopkins would indicate true north on land, it was found to be tremendously influenced by accelerating and retarding forces when attempt was made to use it on a moving ship, and for navigating purposes it was therefore wholly useless. Many other workers then took up the task of producing a mariner's gyro-compass, but a score of years elapsed before success came. Dr. Anschutz-Kaempfe, of Hamburg, Germany, finally succeeded in constructing a gyro-compass (1905) which would for a short time hold the meridian, despite speed, course, latitude and roll of the ship—a truly wonderful achievement when one considers that the directive force which the gyro-compass receives comes from a point some 4,000 miles distant—i. e., *the axis of the earth.*

Coincident with the work of Kaempfe was that of Dr. Schlick (1904), the well-known Hamburg scientist, who produced the first stabilizer, using a "passive" gyro; then Brennan and Froelich built monorail cars.

During this time there was another worker in the field; few knew of his activity, none knew what he was accomplishing. He alone understood that the discoveries of his co-workers, which were being heralded as "inventions of tremendous commercial value" were really based on wrong principles. This man was Elmer A. Sperry, of New York. Five years ago the United States Government tested his first gyro-compass and to-day every United States battleship, cruiser and submarine is equipped with it, as are the ships of nearly every first-class navy of the Old World; a number of battleships, transports and private yachts are stabilized by his "active" gyroscope; his gyroscopic aeroplane stabilizer recently won first prize in competition with nearly every type of aeroplane stabilizer manufactured, and in 1915 he was elected a member of the United States Naval Board.

In addition to the Sperry "master compass," repeater compasses, electrically connected with the master compass, are located at various parts of the ship. An interesting feature is the "hunting" or vibrating of the repeater compass cards; should this cease the navigator would be warned of some mechanical derangement. The large bowl houses the gyro wheel which spins within its vacuum case at the rate of 8,000 revolutions per minute. The entire apparatus is simple, compact and of wonderful durability—many compasses have been run continuously for months without replenishment of oil or other attention.

The "active" gyro equipment devised by Mr. Sperry for overcoming the rolling of ships consists of three elements: a gyro wheel, a precession motor and a gyroscopic control. The control is so extremely sensitive that it "feels out" the incipient roll of the ship and directs the precession motor which moves the gyro. When the ship manifests a tendency to roll, but really before motion sets in, the control gyro responds to the impressed force of the wave and quickly precesses, closing one contact or the other, energizing the motor which moves the large gyro; the large gyro then actually lays hold of the longitudinal stability of the ship and transfers it athwartship; and this action is repeated first in one direction and then the other, instantly and automatically meeting each fresh energization and quenching it.

As the ship is never allowed to roll very little power is required, each wave being dealt with individually; no sudden stresses are thrown upon the hull, as the forces start at zero and return to zero. The gyro constitutes an ideal apparatus for this sort of work, inasmuch as it is perfectly safe. The comparatively slow motion of the wheel is very inexpensive to develop and maintain, representing only a small fraction of the power required to propel bilge keels; and this power, small as it is, is only required when necessity for stabilizing arises, and then only in proportion to the seas running at the time, where the power for the bilge keels is omnispresent; that is, it is a constant drag in all weathers.

In conclusion it might be of interest to add that whereas the weight of Thornycroft or Frahm anti-rolling tanks equals approximately one-twentieth the ship's displacement, the complete gyroscopic stabilizing equipment constitutes considerably less than 1 percent thereof.

* The Sperry Gyroscope Company, Brooklyn, N. Y.

WORLD'S LARGEST DRY DOCK.—It is now fully expected that the mammoth graving dock which is being built for the Canadian Government at Levis, Quebec, will be ready for service very soon. With a length of 1,150 feet, a width of 120 feet, and a depth of 45 feet, it will be the biggest structure of the kind in the world. Docks of similar size have been planned for the Dominion authorities at St. John, N. B., Halifax, N. S., and at Vancouver, B. C. Canada will therefore be fully equipped for docking the largest vessels that are likely to be built for years to come.

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Letters from Marine Engineers

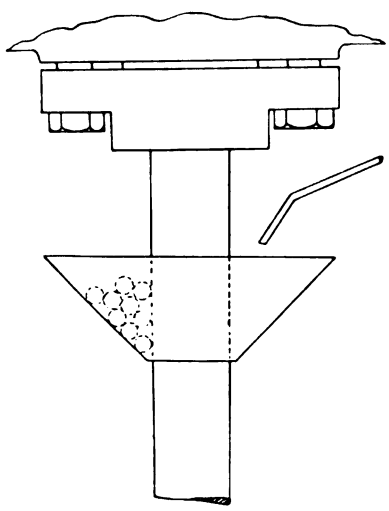
Discussion of the Design and Handling of Marine Engines, Boilers and Auxiliaries—Breakdowns at Sea and Repairs

This department is open to all readers of the magazine for the discussion of affairs in the engine room. All letters published are paid for at regular rates. Your ideas or experiences will be mutually helpful and interesting to other engineers. Write your letter now.

Method Used for Lubricating Vertical Shaft

On a recent trip trouble was experienced with steam leakage on the piston rod of one vertical engine, and no remedy was of avail until a metallic packing was used in the stuffing box. While this stopped the leakage, it resulted in excessive friction and scoring of the rod.

To overcome this we decided to give better lubrication to the rod, and devised an arrangement as shown in the



Sketch of Oiling Device for Vertical Shaft

sketch for oiling the reciprocating shaft. A shield (conical in shape) was placed around the shaft, into which were placed some steel balls for the purpose of evenly distributing the oil, which was introduced drop by drop through the oil pipe shown. This method worked out very satisfactorily and kept the rod in good shape until the end of the trip, when permanent repairs and overhauling could be made.

Philadelphia, Pa. W. A. Lailer.

Getting the Idea

It is rather annoying for those in charge to deal with the fellow who does not seem to get the hang of things. Perhaps little, if anything, counts up more to favor a man's advancement than ability to catch the ideas and thought of his employer or immediate superior. When certain instructions are being given to you about the work in hand, etc., you must form the trait of getting the idea, or meaning, and not have to be constantly consulting your chief about what to do. Some fellows listen to instructions, and after the chief has finished them will say that they understand them; yet when they try to carry out these instructions they mix things up, or perhaps act to the contrary. This very plainly shows that they failed to get the chief's meaning or ideas.

A fellow must use his thinker to make good at steam engineering. Failure on your part to do your share of thinking burdens your fellow men and your chief with the task of thinking for you, and places you in the ranks of sluggish failures.

You have been allotted the same amount of gray matter that your fellow men have. There is but one way to develop the thinker, and that is to train yourself to be attentive to instructions and reason out why they were given. You would not voluntarily put your right hand in a sling and try to do all of your manual work with the lone left hand. Then why not use the full power of your thinker instead of voluntarily allowing it to go into disuse by letting the chief do your thinking?

When you begin to think for yourself, you will then be able to take the initiative in many things. Initiative is the power to plan and to supply the right ideas and carry them out. It is the key to unlock the shackles of the slave to drudgery and carry you to leadership and mastery.

Chief.

Block Signal for Marine Engines

No doubt most marine engineers have experienced (or at least heard of) the old, old mistake which happens on the best regulated of boats—that of improper handling of the engines, according to orders from the bridge. Much needless damage has been wrought in the past to fine ships and many docks, to say nothing of lost "papers" and, what might be considered worse for the engineer, the loss of prestige. And all because some insignificant, trivial thing occurred to distract the engineer's attention

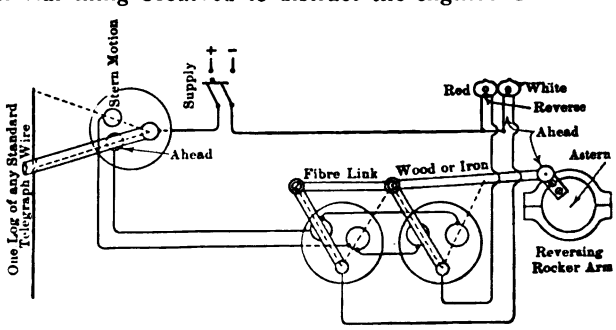


Diagram of Block Signal Arrangement

at a time when his faculties are running more or less along a mechanical rut of thought, rather than the true principle of the thing.

I shall not attempt to discuss just what constitutes a good engineer in the making, but rather have in mind what has happened in the last and suggest something to boost his many fine qualities as well as the reliability of the "black gang."

The following is offered to those young engineers who possess a slight knowledge of electricity and who have usually that "snippy" feeling when the "Old Man" stands just at their elbows during each operation of answering

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bells. They are the men who will profit and win approval with a smile of encouragement from the "chief."

Go up town to some electrical supply house and spend less than a dollar of your own change in securing three small two-point switches and some No. 12 wire or heavier. Possibly all the material can be found in the ship's storeroom. If so, you will be ahead of the game.

Proceed as per "sailing directions" given in the sketch for your own amusement and profit and become insured against that moment you fear as you would a submarine.

This simple, reliable electrical block system suggested may be "hooked up" either to ring a bell or to run from the regular lighting service to light red and white lamps, whichever is most convenient and may be depended on automatically to jog the operator's memory in case he works the engine contrary to telegraph orders.

HARRY A. LIVINGSTON.

Cracked Engine Column Repaired at Sea

The following is an account of a recent breakdown and the repairs effected on a ship on which the writer was engaged in the engineering staff. During a lull in a somewhat severe storm, it was observed that a crack had developed just below the top flange of the low pressure front column. The extent of this crack, as may be seen from the accompanying sketches, was approximately from the inside bolt hole on "after side" of column—round the back—and to the corresponding hole on "forward side" of column. While the engine was in motion, and due to the stresses set up, the crack was noted as opening and closing to quite an appreciable extent. It was consequently deemed advisable to effect an immediate repair while the weather had so moderated, and especially as it was learned from the deck department that there was every sign of the storm rising again very quickly.

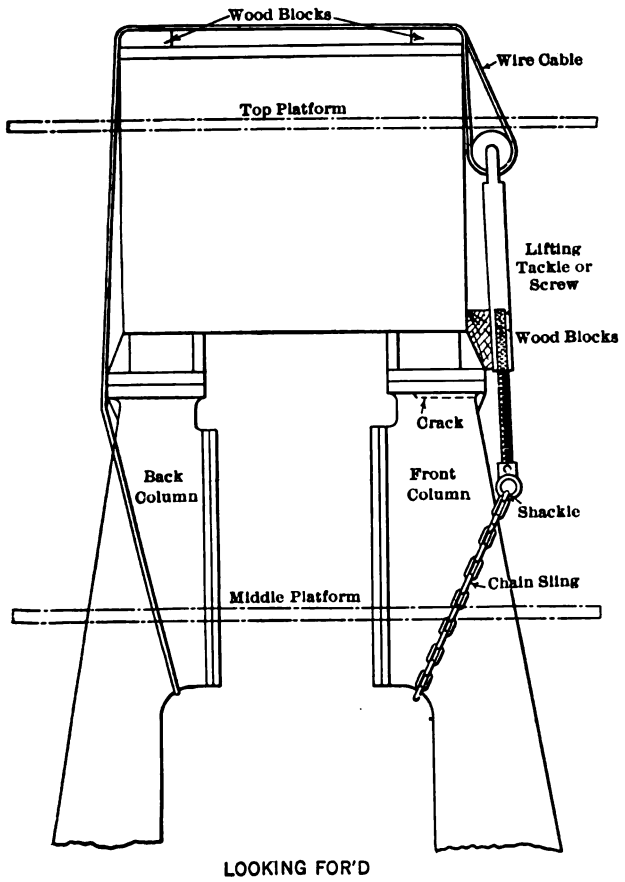

Fig. 1.—Temporary Repair

The temporary repair consisted of the utilization of the lifting screw for the cylinder covers, piston junk rings, etc., being adopted as a chain screw and being placed in such convenient position as to be accessible for tightening up as required. A chain sling was attached round the affected column below the guide, and by means of a shackle to one end of this temporary chain screw, while

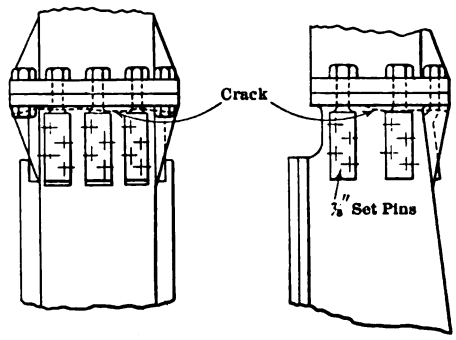

Fig. 2.—Permanent Repair

round the roller end of screw a long length of wire cable was passed, and after being run over the cylinder top was led down beside the back column and passed round below the guide (similar to position of chain sling on front column) and then back over the cylinder top again to the roller. The wire was wound 5 or 6 times, and the ends then made fast. A good strain was then put on screw and the engines slowly started away, this repair only taking twenty minutes.

As the repair was observed to be satisfactory, the engines were soon full away again. In the meantime orders were given to take up a little strain every hour for a time to compensate for the slight "giving" of the wire. Upon reaching port, four days later, a permanent repair was effected by the substitution of bolts, made as shown, the bolt heads being of rectangular section and made fast to the column by ⅞-inch "set pins," as we term them on the Clyde.

The cause of the development of such a crack was attributed to the severe stresses set up by the excessive racing over such a prolonged period (as we were in the storm for fully five days and nights), in conjunction with the slacking back slightly of the column head bolts.

Govan, Scotland. G. M.

A Peculiar Accident

A peculiar and apparently unexplainable accident occurred recently to a boiler in a fishing steamer while tied up to her wharf for the night.

This vessel was fitted with the two Almy watertube boilers, two furnaces each, placed alongside of each other about amidships. When the vessel had been tied up for the night the injector was started while the fires were being banked, and run until the water overflowed into the steam pipe and stopped the injector. The fires were banked by shoving back and covering over with green coal.

About 10 P. M. the engineer went below before going to bed and found everything all right, but at 5 A. M., when the fireman was starting to spread the fires, the sections in the back end of one furnace were found melted together on a line with the top of the fire where banked. No water was found in either boiler.

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The apparently unexplainable part of this accident is the fact that neither the sections in the other furnace of this boiler, or any of the sections in the other boiler were damaged; also the cause of heat intense enough to melt the sections that were damaged was a mystery, it being very evident that a banked fire would not engender enough heat to melt them, even when they were dry. The portions of the sections in direct contact with the fire were not damaged, while the entire sections above the level of the fire were fused together.

J. S.

Finding Faults in Cables and Connecting Wires

Faults in cables, and the wires leading from them to lamps, motors, switches, etc., are usually very difficult to find. It is much easier to find them with the modern arrangement of distribution, where feeder cables lead from the main switchboard to distributing boards at fixed points that are conveniently placed; and sub-feeders lead

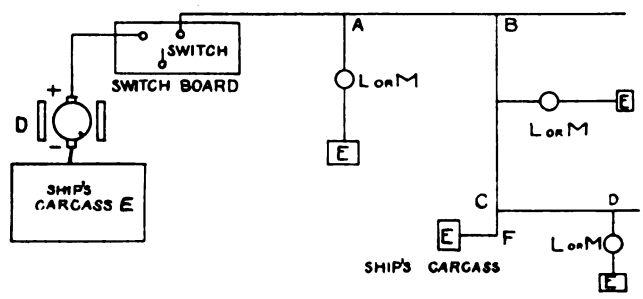

Fig. 1

from the distributing boards to branch distributing boards, also at fixed points easily got at, from which the smaller connecting wires lead to the lamps and switches, than with the older method, the tree system.

The insulation of cables very often deteriorates, sometimes at a slow rate, sometimes more rapidly; none of the insulating materials will stand wet or oil; and all of them are very susceptible to mechanical injury. Where a ship

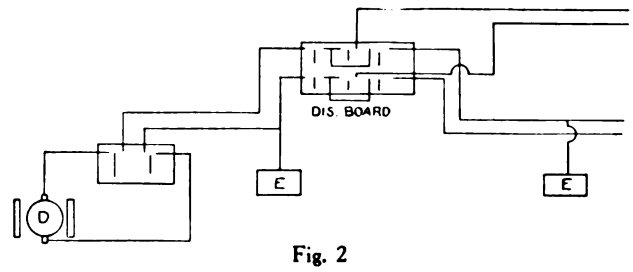

Fig. 2

is exposed to large changes of temperature, as where she is trading between the Tropics and some port where the temperature is very low during some parts of the year, the stresses set up by the difference in the expansion and contraction of the different substances of which a cable is formed are also apt to cause damage to the insulating envelope and often to open the way for further deterioration of moisture.

Where the single-wire system is employed, when the hull of the ship forms the return conductor, faults are more easily discovered, because only one fault is sufficient to cause a breakdown; but against that there is the distinct advantage that with the double-wire system, in which the return currents are carried by a second set of wires and cables, it takes two faults to cause a breakdown. Fig. 1 illustrates diagrammatically how a single fault on any cable in the single-wire system causes a breakdown, because the whole of the current flows through the fault, and through the hull of the ship, back to the generator, in place of through the lamps or motors. Fig. 2 shows how it is necessary for two faults to occur on the two-wire system before a breakdown can occur.

With a single fault there need be no interference with the working of the lamps or motors; but when a second fault occurs the current passes from the fault in the positive cable to the hull of the ship, and thence from the hull of the ship to the fault in the negative cable, and thence back to the generator. The difficulty with the two faults on the two-wire system is: they may be in quite different parts of the ship—that on the positive wire may be in the forecastle, and that in the negative wire in the afterhold, to take extreme cases.

By a fault is meant a connection, either directly or indirectly, between the cable carrying the outgoing current and that carrying the incoming current; with the single-wire system the connection is made directly between the

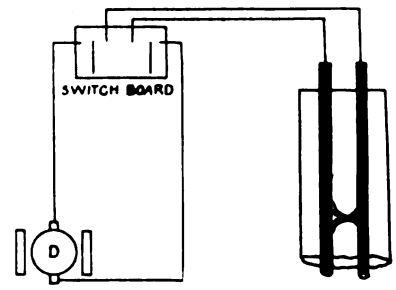

Fig. 3

conductor of the cable and the hull of the ship; the connection may be made between the copper conductor and the iron armor where that is used, or the lead covering where lead is employed, and between the armor or the lead and the hull of the ship. The connection causing the fault is due to the insulation of the conductor having broken down, and usually a spark having passed between the conductor and the armor, or the lead, or even the frame of the ship itself, usually welding the conductor to the other metal that received the spark. With the two-wire system two such connections are made between the copper conductor and some metal in contact with the frame of the ship; but where the positive and negative cables are fixed close together, either in the twin form or separately, a direct connection may be made between the two, as shown in Fig. 3. Electrical engineers call these faults "short circuits" or "shorts"; they form short paths for the current to flow round in place of flowing through the lamps and motors.

A point should be noted in connection with the action of short circuits; it will easily be understood that when a "short" occurs between two feeders, leading from the main switchboard to a distributing board, all current is cut off to lamps and motors beyond; but it is not so easy to understand that a short may occur right at the far end of a distribution service, say between two small wires leading to a single lamp or to a small motor, and it may cause the temporary cessation of supply of current to a large portion, sometimes to the whole of the lamps and motors in the ship. The reason for this is, the "short," by removing the resistance of the lamps, motors, ec., by bridging them over, with a very low resistance, causes the flow of a very

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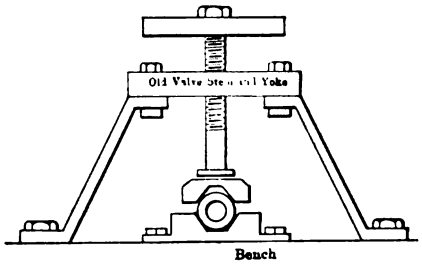
powerful current through all the cables and wires that are connected to those in which the "short" has been formed. The flow of this large current causes a heavy fall of pressure right throughout the distribution service, in accordance with the formula $E = CR$; where E is the fall of pressure in volts, C is the current flowing in amperes, and R is the resistance in ohms.

The distribution service is so arranged that when the lamps and motors are in use the fall of pressure between the main switch board and any individual lamp or motor is very small, not more than 2 volts in a 100-volt service, or 5 volts in a 200-volt service; when the larger current due to the "short" is flowing, the drop in voltage may easily be 50 to 80 volts on 100-volt service, and proportionately on a 200-volt service, or even more.

Bath. SIDNEY F. WALKER.

Extra Bench Pipe Vise

We had a large size globe valve lying in the junk bin of the storeroom. It had been reseated many times, and therefore of no further use. One of the oilers removed



Bench Pipe Vise Formed by Stem and Yoke of Large Globe Valve

the yoke and valve stem from it, and with a couple of pieces of flat 1¼ by ½-inch wrought steel stock, and a few bolts, made an extra pipe vise. This has come in very handy, and as the V blocks are portable the vise can be used for holding down square stock to the bench.

JUNIOR.

Read the Ads.

As I look through the ads. in my trade magazine,
I think of their value and just what they mean.
I know where I'm at, and don't have to converse
With salesmen whom sometimes I afterwards curse.

They tell me how wonderful all their goods are;
Much better than others! You'd have to go far
To find better value! They're best in the land—
And thus they go on with their stories so grand.

They won't put in writing the things that they say,
It means backing up claims! That's out of their way.
But—the ads. that I read make me know where I'm at;
I'll get value received—I'm certain of that.

Concord, N. H. C. H. WILLEY.

SHIPPING BOARD BUREAU OF SEA SERVICE.—The establishment of a sea service bureau, with Henry Howard, director of recruiting, in charge, is announced by the Shipping Board. The object of the new agency is to arrange positions for men graduated from the navigation and engineering schools recently established by the board. Its headquarters will be in Boston.

These schools have been started at various colleges with the object of training men who have had experience as either engineers or seamen to be officers of the merchant marine. The first class was recently graduated from the school at Harvard University.

BOOK REVIEWS

THE TRADE OF TO-MORROW. By Ernest J. P. Benn., Pages, 252. London, E. C., 1917: Jarrolds Publishers, Ltd. Price, 2/6.

Of vital importance to the commercial interests of each one of the nations now allied in the struggle against the Teuton powers is "the trade of to-morrow," or trade conditions after the war is ended. The author is an authority on the subject of trade, having already published a book reviewed in these columns entitled "Trade as a Science." As an Englishman, Mr. Benn naturally looks at the subject from the point of view of his own country, but the subject is covered in such a broad manner as to make the book of universal value. Practical and detailed proposals are made for the reconstruction of British industry after the war, and this subject is treated not only from the viewpoint of the employer, but also from the equally important viewpoint of the laborer.

HANDBOOK OF SHIP CALCULATIONS, CONSTRUCTION AND OPERATION. By Charles H. Hughes. Size, 4⅝ by 7 inches. Pages, 740. Illustrations, 115. New York, 1917: D. Appleton & Co. Price, $5 net.

As announced in the preface, this handbook has been compiled for the purpose of assembling in a single publication, in convenient form, practical data for every-day reference, for men engaged in the designing, building and operating of ships—theoretical calculations being purposely omitted. The book is divided into ten sections, dealing with the following subjects: (I) Weights, Measures and Formulæ; (II) Strength of Materials; (III) Shipbuilding Materials; (IV) Ship Calculations; (V) Hull Construction; (VI) Machinery; (VII) Electricity; (VIII) Heating, Ventilation, Refrigeration, Drainage, Plumbing and Fire Extinguishing Systems; (IX) Ship Equipment, and (X) Ship Operating.

While the book contains a great deal of extremely useful information and data for the various classes of men which it is intended to reach, it must be obvious at once that the scope of the work is too broad for the author entirely to fulfill his purpose. In the preface, for instance, the author claims that such subjects as electric propulsion, geared turbines, Diesel engines and oil fuel are fully treated, as are also recent and special types of construction, such as tankers, battle cruisers, submarine chasers and submarines. As a matter of fact, in the case of battle cruisers, for instance, only a single paragraph of less than a page length is given, and in this case, at least, the subject can hardly be said to be fully covered. Similarly, under the heading of weights of turbine machinery, no specific figures are given, but the subject is passed over with a brief statement to the effect that with turbines there is a saving of weight and space. With the extensive use of steam turbines in both naval and merchant ships, there surely should be available data covering actual weights of such machinery in specific cases. In the case of reciprocating engines valuable data of this kind are given.

The above cases are, of course, by no means a measure of the value of the book, for such sections as those dealing with hull construction, structural details and ship equipment contain much data that are not readily accessible elsewhere.

UNITED STATES MAY BUILD RIVER FLEET.—The feasibility of the government constructing a fleet of barges for the Mississippi and other Western rivers to ease the burden of traffic on the railroads is being considered by the Department of Commerce.

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Questions and Answers for Marine Engineers

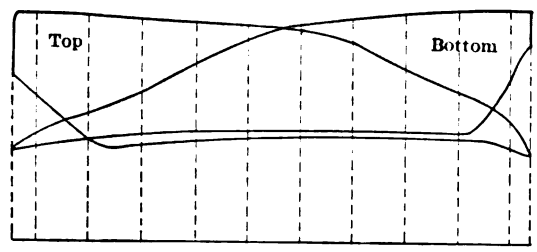
Inquiries of General Interest Regarding Marine Engineering and Shipbuilding will be Answered in this Department

BY H. A. EVERETT *

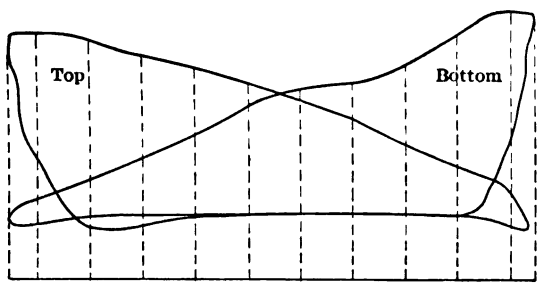
This department is maintained for the service of practical marine engineers, draftsmen and shipbuilders. All inquiries should bear the name and address of the writer. Anonymous communications will not be considered. The identity of the writer, however, will not be disclosed unless the editor is given permission to do so. Indicator cards taken from marine engines will be carefully analyzed, the defects pointed out and the horsepower calculated, provided complete data are sent with cards.

Analysis of Indicator Cards

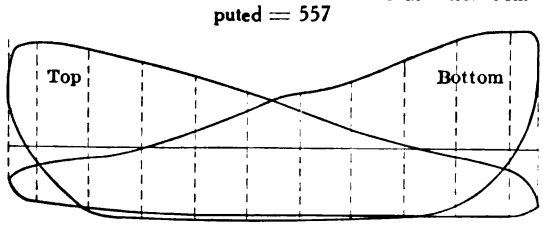
Q. (868).—Please give an analysis of the enclosed indicator cards. I am of the opinion that much better results could be had by a better distribution of the power, but will be pleased to have your opinion of this matter.



I. H. P. of High Pressure Card as First Computed = 404



I. H. P. of Intermediate Pressure Cards as First Computed = 557



I. H. P. of Low Pressure Cards as First Computed = 759.
Total I. H. P. = 1,720

A (868).—The recomputation of the cards by means of a planimeter is given below and differs but slightly from the results attached to the cards:

$$\text{H. P., high} = \frac{2 \times 60 \times 4 \times 490.9 \times 58}{33{,}000} = 414$$

(M. E. P., top, 50.0; bottom, 55.0)

$$\text{H. P., int.} = \frac{2 \times 29.25 \times 4 \times 1{,}320 \times 58}{33{,}000} = 543$$

(M. E. P., top, 32.0; bottom, 26.5)

$$\text{H. P. low} = \frac{2 \times 14.2 \times 4 \times 3{,}632 \times 58}{33{,}000} = 725$$

Total H. P. = 1,682

(M. E. P., top, 14.6; bottom, 13.8)

The card from the low-pressure cylinder presents no abnormal features and is good for this type of engine. The cards from both the high and intermediate cylinders, however, show serious defects in the exhaust line, both showing a serious restriction and consequent rise in pressure in a line which should be horizontal and level with the lowest pressure at the end of the toe of the card. It is more noticeable in the high-pressure cylinder and causes a serious reduction in power (probably over 150 horsepower) for this cylinder. This increase in pressure on the exhaust stroke may be due to insufficient port opening of the valves or insufficient area of passages to the receiver.

If the exhaust lap of the valve on both of these cylinders does not entirely uncover the exhaust port when the valve is in its position of greatest displacement, then either increasing the valve travel by increasing the eccentricity or decreasing the amount of the exhaust lap will probably remedy the defect, but if the ports are entirely open, then the trouble lies in the restrictions which the passages offer and the remedy is difficult.

If you will send on the dimensions of these passages, I will tell you whether the trouble lies with them or not.

Data from Indicator Cards

Q. (896).—Will you kindly answer the following questions in reference to the inclosed indicator cards: Valve gear is Stephenson link motion, slide valves on I. P. and L. P., piston valve on H. P., all taking steam on the outside. The engine is very slow in picking up her speed astern, and one can see that the I. P. engine is being dragged along.

(1). Is this caused by too much angular advance of the eccentric?

(2) If so, and it is to be reduced, kindly give formulæ and example for doing it.

(3). Kindly criticise the inclosed cards and suggest how the I. P. engine indicated horsepower can be increased without greatly altering the power of the other engines.

(4). When taking the atmospheric line of an indicator card and using a one-way cock in conjunction with the usual three-way cock, after shutting the three-way cock, should the pin or drain hole in the one-way cock be set to allow the atmosphere to communicate with the indicator or should it be shut off entirely?

(5). Have I computed the horsepower correctly?

A. (896).—(1) The loop in the cards will be eliminated and the area of each increased by decreasing the angular advance, and this should be done. It is doubtful, however, if the irregularity in turning moment which you notice is principally due to the intermediate cylinder. From the low pressure card for the ahead condition there is a decided difference in the work done on the top and bottom ends, and if the same condition is in evidence when reversed it is probable that this is the principal cause.

(2) There is no fixed rule for the amount of reduction of angular advance, your engineering experience and judgment will have to suffice. It is sometimes helpful to lay out on the indicator diagram the points where you wish the event under discussion (in this case compression) to occur. Draw a semi-circle with the atmospheric line as a diameter, and on it project the original and the new points, draw radii to these points and the angle between will be approximately the angle which the crank should

* Professor of Marine Engineering, Post Graduate Department, United States Naval Academy, Annapolis, Md.

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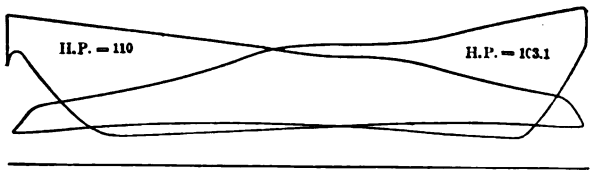
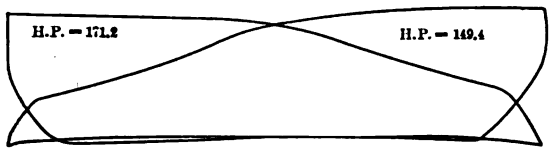
be turned through from the original point of compression to the new position at which the valve should be reset to horsepower could not be computed.

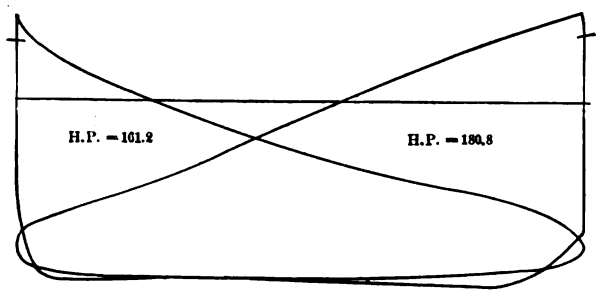
(3) The principal defects in the cards are the inequality in the work of the top and bottom ends of the low pressure cylinder and the small amount of work done by the



High Pressure Cards

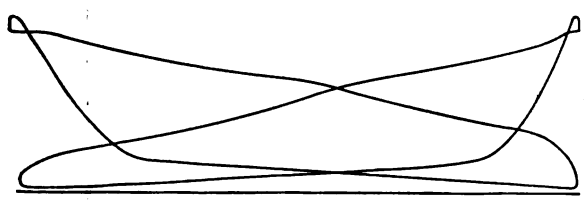


Intermediate Pressure Cards



Low Pressure Cards

intermediate cylinder. This latter will be helped by lengthening the cut-off of the high pressure cylinder. This would be done most easily by adjusting the gag-screws on the high pressure links. It would also help matters to lengthen the valve rod slightly. This would equalize the cards somewhat, as it would advance cut-off and release and delay admission and compression for the top end and



Astern Card

would have the converse effect for the bottom end. The low pressure card would also be much improved by a change in the length of the valve rod. In this case, however, the rod should be shortened. This will delay cut-off and release and advance admission and compression for the top end, which will tend to equalize the areas.

(4) The cock should be so set that the cylinder of the indicator is in free communication with the atmosphere whenever the atmospheric line is drawn.

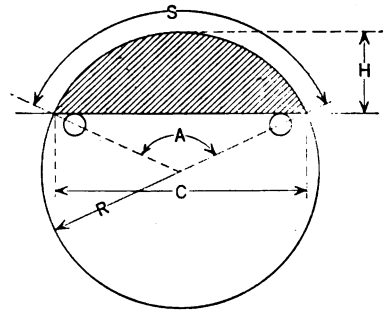
(5) The detailed computation for horsepower is given below. Apparently you did not take account of the areas of the piston rods. In the computations appended it was assumed that there were no tail rods; if such is not the case the results should be changed to conform. As the revolutions were not given for the astern condition the horsepower could not be computed.

Cyl. H. P.	Area, Sq. Ins.	Length Ins.	M.E.P.	Spring	Piston A	I.H.P.	
Top	2.86	4.02	56.9	80	380.1	154.8	
Bottom ...	2.92	3.96	58.9	80	360.7	152.0	306.8
Int. P.							
Top	2.21	4.28	15.49	30	962.1	106.6	
Bottom ...	2.20	4.28	15.41	30	946.0	104.3	210.9
L. P.							
Top	4.08	4.23	7.72	8	264.2	146.0	
Bottom ...	5.03	4.23	9.50	8	262.3	177.9	323.9
Total							841.6
ASTERN COND.							
I. P.							
Top	2.22	4.18	15.94	30	962.1		
Bottom ...	1.97	4.18	14.12	30	946.0		

Area of Segment of Boiler Head

Q. (904).—How do you figure the area of the space between the top row of tubes and the boiler shell in a Scotch boiler?

A. (904).—The area above the tubes will be the area of a segment of a circle shown cross-hatched in the accompanying figure. The easiest way to compute this area is from a table of areas of circular segments, such as is given



Sketch Showing Dimensions for Computing Area of Segment

in most handbooks (see Pocket Companion, issued by Carnegie Steel Company), which gives coefficients by which the product of the chord and rise may be multiplied to get the area at once.

Two formulæ for this area are given below:

$$\text{Area} = \tfrac{1}{2} R^2 [\text{rad. } A - \text{sine } A] \quad (1)$$

$$\text{Area} = \tfrac{1}{2} [R (S - C) + C H] \quad (2)$$

rad. A is the angle A in radians or the length of arc divided by the radius.

Movement of Valve Due to Movement of Eccentric

Q. (903).—Diameter of shaft, 15 inches; throw of eccentric, 5 inches; how much will the valve move if the eccentric is moved ⅛ inch?

A. (903).—The valve will move anywhere from ⅛ inch to 0 inch, depending upon the location of the eccentric when the movement is begun. The length of the eccentric rod is great compared with the eccentricity, and we may assume harmonic motion, in which case, if the eccentric is on a dead center, the movement of the valve is

$$5 - \sqrt{(5)^2 - (\tfrac{1}{8})^2} = 0,$$

very nearly.

If the eccentric is at 90 degrees from the vertical, the movement will be ⅛ inch, very nearly.

BRITISH WARSHIPS BUILDING IN THE ORIENT.—Vessels are under construction for the British Government at Kobe, Yokohama and Hong Kong. At the Kawasaki dockyard, on June 26, a cruiser developing 16½ knots was completed for Great Britain.

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LAKE WASHINGTON CANAL FORMALLY OPENED

Completion of $5,000,000 *Project Marked by Fitting Ceremonies on July* 4

Fig. 1.—Lake Washington Canal Locks. From Left to Right—Pumping Station, Large Lock, Auxiliary Lock, Salt Water Drain Spillway, Fish Ladder

Fig. 2.—Admiral Peary's Polar Exploration Ship *Roosevelt* Leading Pageant Through the Canal at Formal Opening on July 4

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Shipbuilding and General Marine News

Contracts for New Ships—Shipyard Improvements—Engineering Projects—Improved Appliances—Personal Items

UNITED STATES WILL BUILD GREATEST FLEET OF DESTROYERS IN THE WORLD

Appropriation of $350,000,000 Will Be Asked from Congress

Shipbuilding facilities in the United States will immediately be expanded so that the output of torpedo boat destroyers can be doubled or trebled during the next eighteen months. For this purpose an appropriation of $350,000,000 is being asked by the Navy Department.

The above proposal was discussed at a recent conference between the Secretary of the Navy and representatives of twenty-five or more ship and engine builders. According to the shipbuilders, this large building programme cannot be undertaken without financial aid from the Government. The specific demands from the shipbuilders were as follows:

The Government must finance the establishment and building of the plants.

The plants must be entirely new, as all now in existence are being worked to their full capacity.

The shipbuilders will be willing to accept contracts on a percentage basis.

The Government will have to condemn the land on the sites where the plants are to be situated.

It is understood that the Navy Department is in favor of concentrating every possible shipbuilding resource upon the construction of a destroyer fleet that will be larger than that of any other naval power.

An important question involved in this immediate expansion of shipbuilding resources is the ultimate ownership of the new yards. While the Government would own them for the duration of the war, it is uncertain whether private shipbuilders could keep them in operation after the destroyer fleet is completed.

Lake Washington Canal Formally Opened

Vast opportunities for industrial development and commercial expansion were made available for the business interests in Seattle, Wash., at the formal opening on July 4 of the Lake Washington Canal, which connects Lake Washington with Lake Union and Puget Sound. The event was marked by a marine pageant in which several thousand vessels of all classes participated, the pageant being headed by the historical polar ship *Roosevelt*, which carried Rear Admiral Robert E. Peary on his North Pole expedition.

The canal is about 8 miles in length from Puget Sound to Lake Washington, and by its completion more than 60 miles of additional water frontage are given to Seattle, thus enabling ocean-going shipping to make use of the non-tidal fresh water basins of Lake Union and Lake Washington. Besides being of benefit for commercial purposes forethought has been given to the advantages of this project for naval purposes. As the water in Lakes Washington and Union never freezes, a splendid winter anchorage is available for vessels which are generally laid up for the winter months for fitting out and overhaul.

The locks of the canal, which were opened twelve months ago, and which were described in our September, 1916, issue, are second in size only to those of the Panama Canal. The main lock, which can accommodate any ship now afloat on the Pacific, is 825 feet long, 80 feet wide and 50 feet deep. The auxiliary lock is 150 feet long, 30 feet wide and 30 feet deep. Although the construction of the canal was suggested sixty-four years ago, it was not until 1911 that actual work on the project was begun. The total cost of construction was about $5,000,000.

Bowles and Snow Appointed Assistants to General Manager of Emergency Fleet Corporation

Rear Admiral F. T. Bowles, U. S. N., retired, and Naval Constructor Elliot Snow, U. S. N., have been appointed special assistants to Rear Admiral Capps, U. S. N., general manager of the United States Shipping Board Emergency Fleet Corporation.

Rear Admiral Bowles was Rear Admiral Capps' predecessor as chief constructor of the United States Navy, and after his retirement from the navy he was for several years president of the Fore River Shipbuilding Company. Naval Constructor Snow has been in charge of naval construction at the League Island Navy Yard, Philadelphia.

British Shipping Losses Dwindle to 320,000 Tons in July

Premier Lloyd George, speaking in the House of Commons on August 16, stated that during the month of July only 320,000 gross tons of shipping were lost through German submarines, and that during this month there was a substantial improvement over July.

Although 560,000 gross tons of shipping were lost in April the net losses since the commencement of Germany's unrestricted submarine warfare has been under 250,000 tons a month.

Premier Lloyd George also said that in the first six months of this year the new tonnage built in Great Britain was 484,000, while in the last six months, including purchases, the new tonnage would amount to 1,424,000. A considerable addition has also been made in the programme of naval construction. With the co-operation of America, the Premier said there would be sufficient tonnage for all of 1918, and, if necessary, for 1919.

SHIPPING BOARD PLANS TO BUILD 1,270 VESSELS

Programme Calls for Nearly 8,000,000 Tons of Merchant Shipping

Additional Appropriation of $1,134,000,000 Required

According to a statement recently submitted to the Secretary of the Treasury for transmission to Congress, relative to the Government merchant shipbuilding programme, the United States Shipping Board asks for an additional appropriation of $1,134,000,000. Of this amount it is estimated that $719,000,000 will be required for contracts for steel and wooden vessels; the sum of $265,000,000 will be required for commandeering ships at sea, and the remaining $150,000,000 will be used in moving available tonnage from the Great Lakes to the seaboard.

The building programme is as follows:

BUILDING PROGRAMME

	Number	Tonnage	Estimated Cost
Ships contracted for	433	1,919,200	$285,000,000
Ships ready to be contracted for when funds are available	452	2,968,000	455,500,000
Ships under negotiations	237	1,281,400	194,000,000
			$934,500,000
Miscel'n'ous vessels	150	1,800,000	300,000,000
Organization and other miscellaneous expenses			35,000,000
Amount authorized by Congress June 6, 1917 ($300,000,000 appropriated)			550,000,000
Amount to be authorized for building programme immediately in sight, making no allowance for changes in cost of labor and material			719,500,000

COMMANDEERING PROGRAMME

For commandeered ships, amount required	515,000,000
For commandeered ships, amount authorized by Congress June 6, 1917	250,000,000
Balance requiring authorization by Congress	$265,000,000

PURCHASE PROGRAMME

For vessels to be purchased other than under construction or commandeered	150,000,000

SUMMARY

Total amount, in round figures, to be purchased in addition to amounts already authorized:	
For commandeered vessels	265,000,000
For construction of new vessels	719,500,000
For purchase of new vessels	150,000,000
Grand total	$1,134,500,000
Amounts desired to be appropriated for remainder of fiscal year 1918:	
For commandeered vessels	$365,000,000
For building programme	400,000,000
For purchase of vessels	150,000,000
Total	$915,000,000

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United States Steel Corporation Begins Construction of Large Shipyard in New Jersey

Erection of the large shipyard of the Federal Shipbuilding Company, which was organized and financed by the United States Steel Corporation, is now under way on the Hackensack Meadows, near Newark, N. J., and it is expected that the first two vessels will be launched on April 1, 1918, and completed on June 1, 1918.

Ten shipways, each about 500 feet long, will be provided, as well as a complete equipment, including a plate shop 165 by 800 feet, with a mold loft 126 by 800 feet on the second floor; a machine shop 125 by 150 feet, boiler shop 160 by 500 feet, forge shop 150 by 300 feet, rigging loft 50 by 150 feet, brass and iron foundry 100 by 300 feet, copper and tinsmithing shop 50 by 150 feet (two stories), joiner and carpenter shop 100 by 150 feet (two stories), power house 100 by 200 feet, main storehouse 50 by 150 feet (two stories), two branch storehouses, each 20 by 50 feet (two stories), and a main office building 70 by 500 feet (two stories).

The shipways are being constructed by the Fraser, Brace Company, New York; the shop buildings, which are of steel framework, with glass, iron and terra cotta sides, covered with stucco, by Post & McCord, Inc., New York, and the structural steel, 10,000 tons in all, is being furnished by the American Bridge Company.

Power for the plant will be supplied by the Public Service, Newark, and all machinery will be electrically driven.

The directors of the Federal Shipbuilding Company are E. H. Gary, James A. Farrell, Joshua Hatfield, Robert MacGregor, Richard Trimble, August Ziesing and W. J. Filbert. E. H. Gary is president; Richard Trimble, treasurer, and W. J. Filbert, secretary. Robert MacGregor is vice-president and general manager.

Wages and Working Conditions for U. S. Seamen

The Department of Commerce authorizes the following:

An agreement has been reached concerning wages and working conditions for men to man the merchant fleets of the country, and it is believed that the agreement renders easy the task of obtaining sufficient qualified men to operate the large number of merchant vessels now building.

The Wage Scale

The wage scale, which will remain in force until a year after the war ends, is as follows: Sailors and firemen, $60 per month; coal passers, $50 per month; oilers and water tenders, $65; boatswains, $70; carpenters, $75. Overtime pay for cargo work is figured at 50 cents an hour, and for ship work 40 cents an hour. A 50 percent bonus is to be paid crews entering the war zone. Employers will pay each seaman $100 compensation for loss of personal effects when a ship is sunk. The scale of wages and bonus for stewards and cooks is unchanged at present.

In order to increase the number of men available for work, each ship will carry a certain number of boys in proportion to number of seamen carried. The number of able-bodied seamen will be reduced; the deficiency will be made up by employing more ordinary seamen. Representatives of the seamen's organizations will be given access to docks and decks.

Termination of Agreement

The committee agrees that bonus and other conditions arising from the war shall terminate with the war, but the wage scale named above shall remain in force for a year after the war terminates. Employers and seamen will unite in an appeal to men who have left the sea to return, and to young men to go to sea as a profession.

The Provost Marshal General's Office will be requested to exempt seamen from military service wherever it can be done, on the ground that the scarcity of sailors makes them more valuable in that capacity than as soldiers.

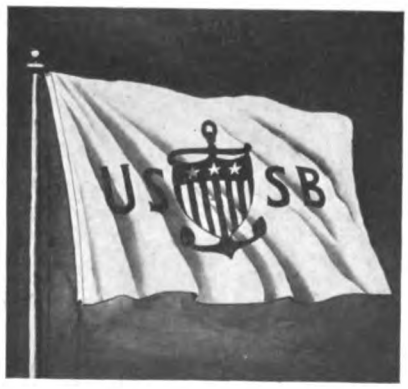
NEW OFFICERS OF UNITED STATES SHIPPING BOARD

E. N. Hurley, Chairman United States Shipping Board

Rear Admiral W. I. Capps, General Manager Emergency Fleet Corporation

Shipping Board's New Flag

In a few weeks there will begin to appear in the Seven Seas a new flag, symbolizing the return of the United States in all its power to fellowship with the leading maritime nations of the earth.



Official Flag of United States Shipping Board

The new standard is the recently-adopted official flag of the United States Shipping Board, and it will fly over all the ships under the Board's control, which will comprise the largest fleet of merchant vessels ever commissioned under one management.

The flag consists of a white ground on which is displayed the National shield in full colors of red, white and blue, supported by a blue anchor, and flanked on the left by the letters "U. S." and on the right "S. B." The proportions of the flag, in the size to be flown by a ship of 8,000 tons, are 6 feet hoist to 9 feet length.

Steamer Eastland to Become U. S. Gunboat

The steamer *Eastland*, which turned over in the Chicago River two years ago, causing the death of more than 800 excursionists, is practically ready for service as a gunboat of the United States Navy.

The steamer has been rebuilt and cut down so that it will be more seaworthy and will be able to steam about 22 knots. She will carry four 3-inch guns and four 3-pounders, and will probably be used as a training ship on the Great Lakes.

Vessels Should Carry Supplies for Round Trip

To assist the allies in conserving foodstuffs and other necessities, Secretary Redfield, at the request of Secretary Daniels, has issued the following important announcement to owners of American merchant vessels engaged in over-seas trade:

Owing to the present shortage of provisions, supplies and stores abroad, all merchant vessels sailing from United States ports for a round trip to any of the belligerent countries should provide themselves so far as practicable with all necessary stores, provisions and fuel for the round trip.

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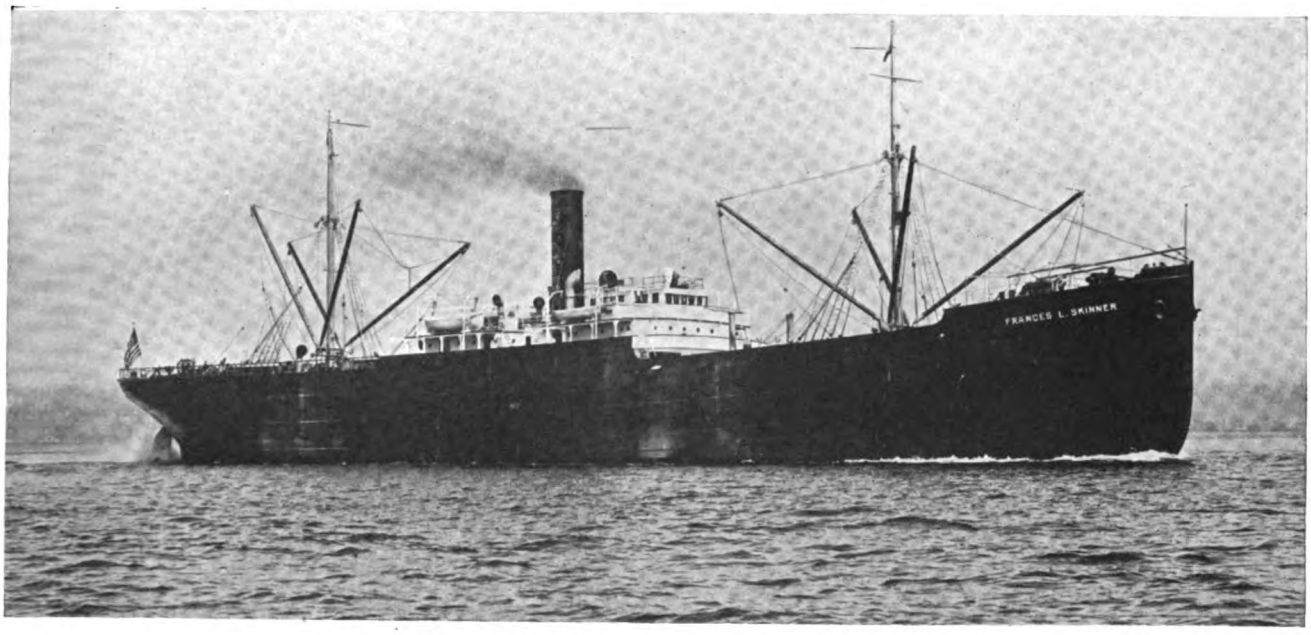

S. S. *Frances L. Skinner*, Formerly the Kosmos Liner *Sesostris*

New Orleans Designated by Shipping Board as Headquarters for Recruiting From Gulf States

Official announcement is made in New Orleans on behalf of the United States Shipping Board that that city has been named by the Board as headquarters for its recruiting service for the Gulf States.

Ernest Lee Jahncke has accepted an appointment from the Shipping Board to act as its representative in the territory.

Philadelphia School Begins Training Marine Engineers

The Philadelphia branch of the United States Marine Engineering School, which opened on August 20, will be the largest in the country. Unlike the other branch schools, it will be the only one with a boat for practical instruction. This feature already has attracted more students for the first term than all other Federal marine engineering schools combined.

Smoke Boxes for Protection of Ships Obtainable

The Bureau of Ordnance of the Navy Department is having manufactured by the Du Pont Company smoke boxes suitable for use by merchant vessels as a means of escape from attacking submarines. The cost will be approximately as follows: Smoke funnel, $125 each; phosphorus, $1.75 per pound; smoke boxes, $25 each.

The smoke funnel is for the production of smoke on board the vessel and requires only the fuel for its continued use. The smoke boxes are for throwing overboard and once used cannot be recovered.

The Navy Department is preparing to issue smoke boxes to all vessels carrying armed guards, and has announced as its policy that smoke-producing apparatus for the use of merchant vessels should be available for every vessel desiring to purchase same. It is urged that merchant vessels give prompt and favorable consideration to the desirableness of purchasing smoke-producing apparatus.

S. S. Frances L. Skinner Sails on Oriental Voyage

On July 18, the *Frances L. Skinner*, formerly the *Sesostris*, the salvaging of which, after lying for ten years on the beach at Ocos, Guatemala, was described in our last issue, left the dock at the Skinner & Eddy Shipbuilding plant, Seattle, Wash., and sailed for Tacoma, where a load of 3,000 tons was taken on board, after which she returned to Seattle to complete her cargo, destined for Oriental ports.

The ship, after having been salvaged by the Skinner Syndicate of Seattle, and brought up the coast under her own steam, was completely remodeled at the Skinner & Eddy plant, practically all the superstructure having been replaced and the entire fittings throughout standardized and brought up to date. The contrast between "the old and the new" can readily be seen by comparing the photograph of the vessel reproduced herewith with those which were published in our August issue.

Lloyd's highest rating has been granted the vessel, and, in addition, her former freeboard has been reduced, giving her a greater deadweight carrying capacity. It is claimed by many who inspected the vessel that when many of the steel ships building to-day retire to the graveyard, the *Frances L. Skinner* will still be afloat in fine condition, due to the fact that the scantlings throughout are of greater dimensions than required by Lloyd's to-day, and that these have not been diminished by disintegration during the long period when the vessel was stranded on the Mexican coast. This latter fact can be ascribed in part to the high quality of steel which was used in the construction, and also to the superior workmanship, of which her builders can well be proud.

SHIPYARD EXTENSIONS AND CHANGES

Consolidations, Sales and Improvements

B. B. Crowninshield, 75 State street, Boston, Mass., W. A. Swasey and associates have incorporated the Crowninshield-Swasey Shipbuilding Company at Fall River, Mass., and have purchased Read Bros.' shipbuilding plant at Somerset, Mass.

The Atlantic Coast Company, a newly-organized corporation, has bought the shipyard of the Townsend Marine Railway & Construction Company, Boothbay Harbor, Me.

The Oregon Shipbuilding Company and the Motorship Construction Company, both of Portland, Ore., have been consolidated, and the latter company's plant at Vancouver will be enlarged. These two concerns are reported to have contracts to build 160 lifeboats.

The Goodrich Transit Company, Chicago, Ill., is planning to spend a large sum of money building repair yards, machine shops, etc.

The Staten Island Shipbuilding Company, Port Richmond, S. I., has awarded a contract to John Miles & Company, Port Richmond, to build a machine shop, blacksmith shop and boiler works.

The construction of 26 new ship ways on the Delaware River has been undertaken by the Traylor Shipbuilding Corporation, whose head office is at present in Allentown, Pa., and by the Chester Shipbuilding Company, Chester, Pa.

L. H. Gray, formerly vice-president of the Anderson Shipbuilding Corporation, Seattle, Wash., has severed his connection with that company and will build another shipbuilding plant at Seattle.

Griswold, O'Donnell Company, Portland, Ore., plans to erect a wooden shipbuilding plant on the waterfront at Vancouver.

The Sandy Point Shipbuilding Corporation, New York, has acquired land and wharf rights at Stockton Springs for establishing a shipyard.

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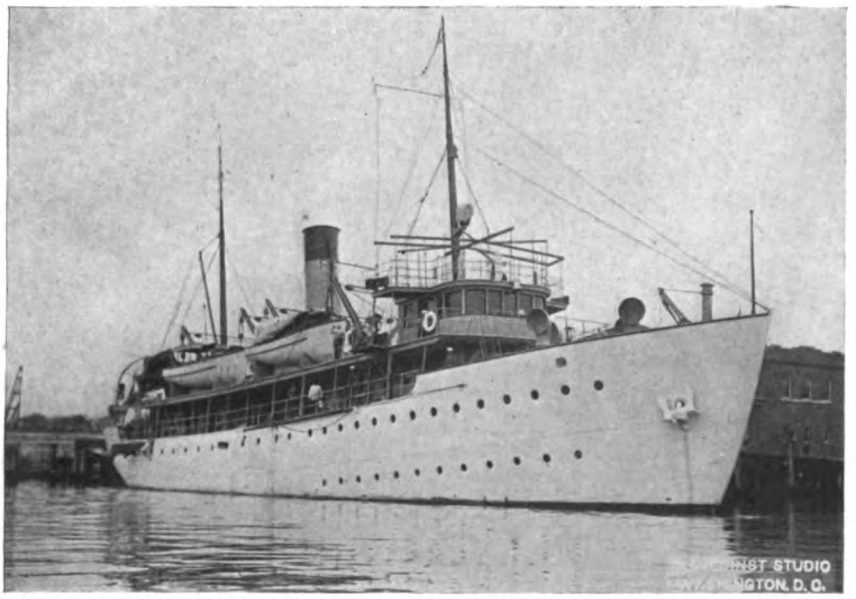

Government Steamer *Surveyor*, Designed for Long Cruises in Alaskan Waters

New Coast and Geodetic Survey Steamer

The *Surveyor*, an all-steel vessel of 1,000 tons displacement, designed for work as an off-shore surveying ship in the North Pacific, and particularly off the coast of Alaska, has recently been completed for the United States Coast and Geodetic Survey. She is 183 feet long, with 34 feet beam and 12 feet loaded draft. Power is furnished by a single triple-expansion steam engine of 1,000 horsepower. Oil is used as fuel in the boilers.

The *Surveyor* has a storage capacity for 75,000 gallons—enough to carry her 5,000 miles at full speed, or 7,500 miles at working speed.

The vessel is equipped with water tanks and storerooms sufficient for a period of six months, and is designed to keep the sea without making port for several months at a time.

Output of World's Shipyards

New merchant ship tonnage, built during the six months from October, 1916, to April, 1917, amounted to 728 ships of 1,667,524 gross tons, according to figures recently published by the Bureau Veritas. The output in the various maritime countries was as follows:

	Number of Ships	Gross Tonnage
Great Britain	261	680,946
United States	150	484,381
Holland	103	190,619
Japan	46	128,913
France	42	61,988
Italy	20	34,051
Norway	42	34,044
Denmark	20	26,348
Sweden	26	20,023
Spain	7	4,422
Chili	3	823
Russia	5	750
Portugal	3	216
Total	728	1,667,524

Owing to the present increase in shipbuilding in both the United States and Great Britain, these figures will obviously be greatly exceeded at the end of the next six months.

SHIPBUILDING COMPANIES INCORPORATED OR PROJECTED

The Supple-Ballin Shipbuilding Company, Portland, Ore., has been incorporated by James Supple, F. A. Ballin and others.

The Coos Bay Shipbuilding Company, Marshfield, Ore., is planning the construction of a shipyard at Marshfield.

The Midland Bridge Company, Kansas City, Mo., announces that it will build a shipyard at Houston, Tex.

The Florida Marine Construction Company has been organized at Jacksonville, Fla.

The American Shipbuilding Corporation has been organized at Beaumont, S. C. R. C. Horne, Jr., and W. E. Richardson are among the incorporators.

The Fay Shipbuilding Company will build a shipyard at Eureka, Cal.

The Merchants Marine Construction Company, Los Angeles, Cal., is planning the construction of a shipbuilding plant at Long Beach.

Oscar E. Jackson, of Duncan, Jackson & Duncan, 79 Wall street, New York, has organized a company with the intention of building a shipyard on Staten Island.

The American Cement Ship Company has been organized in Boston, Mass. The president is H. W. Loker, Boston.

The Dauntless Shipyard, Inc., has been organized at Essex, Conn., by Chas. A. Goodwin and others.

Charles Hall, North Bend, Ore., is at the head of a company which is planning the construction of a shipbuilding plant at North Bend.

The Union Construction Company, Oakland, Cal., is planning to build a shipyard at Oakland.

The Mann Shipbuilding Company has been incorporated and is planning the construction of a plant on Curtis Bay, near Baltimore. W. W. Mann is president.

The Henderson Shipbuilding Company has been organized in Mobile, Ala. Frank Henderson is president; W. T. Henderson, vice-president and treasurer, both of Mobile.

The North Carolina Shipbuilding Company announces that it will build a shipyard at Morehead City, N. C.

Poage & Company, Tampa, Fla., are planning a yard at Tampa, with the intention of building wooden ships.

The Ohio Shipbuilding Company has been incorporated, with headquarters in Cleveland.

The Griswold-O'Donnell Company, Portland, Ore., is planning the construction of a shipbuilding plant at Vancouver, Wash.

The Fernandina Shipbuilding & Dry Dock Company has been organized at Fernandina, Fla.

J. F. Warren, secretary of the Apalachicola, Fla., Chamber of Commerce, states that a shipbuilding corporation has just been organized in his city, and that the construction of a yard will be begun at once.

The Elizabeth City Shipyard Company has been incorporated with headquarters at Elizabeth City, N. C. R. B. Cotter is president, J. Ehringhaus, vice-president.

The Boothbay Harbor Shipbuilding Company has been incorporated by Mayor Cliff, of Somerville, Mass., and associates.

The Bagdad Shipbuilding Company has been incorporated, with headquarat Pensacola, Fla., yard at Bagdad. J. A. Merritt is president; R. W. Turner, secretary, both of Pensacola.

The Hodge Ship Company has been incorporated. O. E. Hodge is president; J. S. Hunt, vice-president, both of Hodge, La.

The Diercks-Blodgett Shipbuilding Company has been incorporated by D. V. Diercks, J. B. Kirkpatrick and others, of Kansas City, Mo. The company will build a shipyard on the Pascagoula River, Miss.

The Tregoning Boat Company, Seattle, Wash., Frank C. Tregoning, president, is planning the construction of a shipbuilding plant at Portland, Ore.

SHIPBUILDING CONTRACTS

Recent Orders for Merchant and Naval Vessels

The Foundation Company, 233 Broadway, New York, which is building shipyards in various parts of the country, is reported to have received contracts from the French Government to build forty sailing vessels.

The Columbia River Shipbuilding Corporation, Portland, Ore., is reported to have received contracts to build several steel vessels for the French Government.

The Gulfport Shipbuilding Company, Gulfport, Miss., is reported to have received a contract to build five steamers.

The contract of the Kelly-Atkinson Construction Company, Chicago, Ill., with the United States Emergency Fleet Corporation, is said to call for 18 composite steamers, and to include all the machinery. The Kelly-Atkinson Construction Company has purchased 16 acres on the Mobile River, Mobile, Ala., and has already started work on its shipyard.

J. F. Duthie & Company, Seattle, Wash., are reported to have received a contract from the French Government to build two 8,800-ton steel steamers.

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The contract of the Hollywood Shipbuilding Company, Oakland, Cal., with the United States Emergency Fleet Corporation is said to call for six 8,800-ton steel steamships.

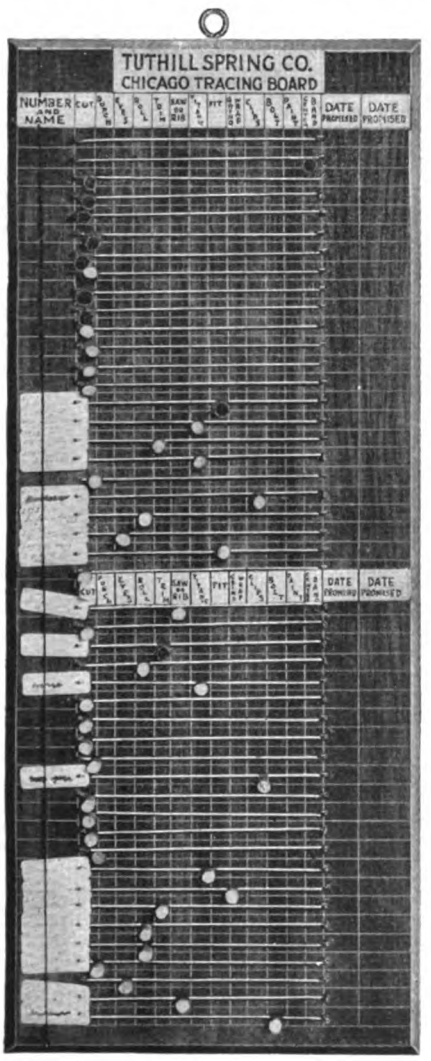
The Elliott Bay Shipbuilding Company, Seattle, Wash., is reported to have received contracts to build four auxiliary schooners.

The Portland Shipbuilding Company, Portland, Me., has received a contract from the East Coast Fisheries Company to build two steam trawlers.

Keeping Track of Orders with a Tracing Board

Keeping tabs on orders so that delays are noticed, the causes discovered, and deliveries made on schedule time, is a problem common with all manufacturers. The Tuthill Spring Company, of Chicago, formerly kept track of the progress of orders through their plant by a card index system. Each day the exact location of each job was noted on a card, and the superintendent or shipping clerk was able to keep posted on just what was taking place by fingering through the cards.

However, an engineer of the Tuthill Spring Company, Mr. Harold T. Moore, trained in working out short manufacturing cuts, devised a better way. The tracing board shown in the picture is the result. The one illustrated is used in tracing Chicago orders. Each day the entry clerk, in much shorter time than it took to make the card records, can bring his tracing board up to date. The merest glance tells the superintendent, or anyone else interested, the exact status of each job.



Tracing Board for Keeping Tabs on Progress of Work in the Shops

How Fabrikoid Is Made

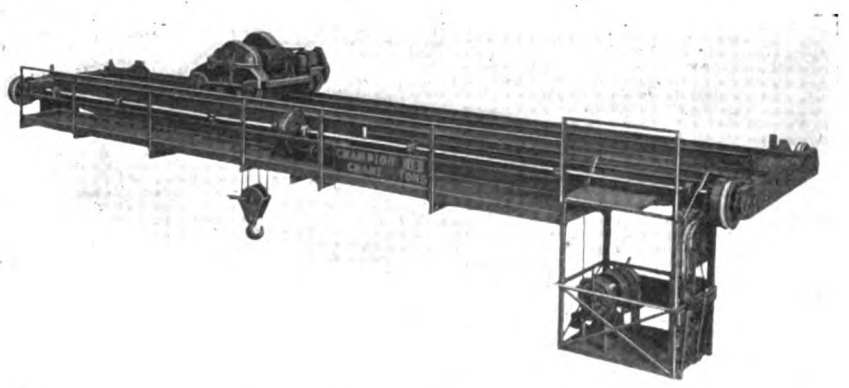
Owing to the scarcity of leather, Fabrikoid, which is manufactured by the E. I. Du Pont de Nemours & Company, Wilmington, Del., has been adopted by the Government as its standard for ship upholstery. Its base is a specially woven fabric of cotton, so designed as to the number and size of the threads in the warp and woof that the finished material will have at least twice the tensile strength of split leather.

After the cotton cloth is carefully examined by experts to guarantee its quality and strength, it is run through die vats, where the material is shrunk, so that the completed product can be depended on not to stretch or sag. After drying, the fabric is ready for the special processes by which is obtained the soft leather-like feel of fabric, the machinery used being especially designed for the purpose. The fabric is then run through coating machines, where it is coated with Pyroxylin solutions. After receiving the coating, which gives the fabric a tough wear-resisting surface, the fabric is passed through embossing machines, where it is made exactly to represent natural leather. Fabrikoid is furnished in about sixty different grains, and the finished material is thoroughly inspected before shipment.

The base of the coating solutions used is raw cotton, which is nitrated and then dissolved in various solvents. The Du Pont Fabrikoid Company, it is claimed, are the only manufacturers in America who nitrate their own cotton, dissolve it in their own solvents, and, to a large extent, make their own coloring pigments. This gives the company a chemical as well as a mechanical control of the entire system of production.

Traveling Shop Cranes Built by the Biggs-Watterson Co.

With a view to meeting the most severe requirements usually called for by shop crane specifications, and at the same time producing a machine from the standpoint of high efficiency, the Biggs-Watterson Company, Cleveland, Ohio, has placed on the market the Champion Crane, which has a capacity of 15 tons. As shown by the illustration, the main frame of the crane is composed of two box-section steel girders, thoroughly braced with heavy gusset plates to prevent twisting of the structure, and fitted with special trucks at each end. On this bridge-like structure the operating trolley containing the lifting mechanism travels. Separate motors operate the trolley and bridge, all operated by controllers in an operator's cage at the end of the crane.



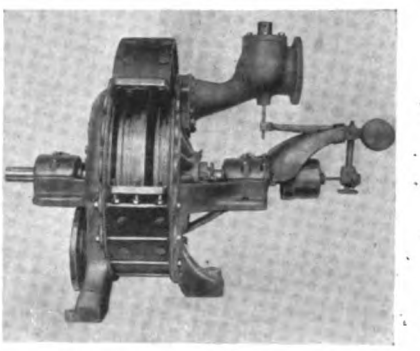
Champion Electrical Traveling Crane

Curtis Steam Turbines for Fans, Blowers and Pumps

The General Electric Company, Schenectady, N. Y., has developed a Curtis steam turbine in a wide variety of capacities to drive fans, blowers and pumps for boiler feeding and circulating systems. It is called the Type L, and is of the impulse type. The number of stages and rows of buckets vary with the capacity.

A split wheel casing is used to permit ready inspection of the buckets, which are of bronze securely dovetailed into the rim of the wheel. The exhaust steam is free from oil and is well suited for heating feed water.

Speed regulation is close and reliable, and the speed may be changed by handwheel adjustment while the turbine is in operation. A constant running speed is maintained by a simple and powerful speed governor mounted directly on the shaft and controlling a double-balanced piston valve type throttle.



Type L, Curtis Turbine

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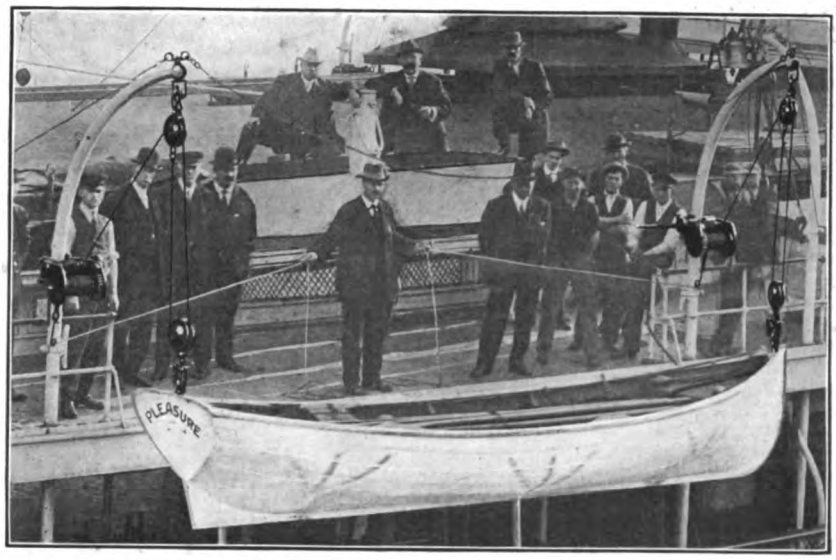
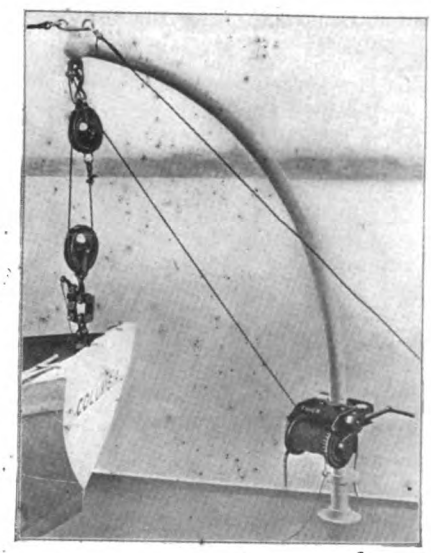


One Man Lowering Lifeboat with J-H Windlass and Releasing Hooks

J-H Lifeboat Windlasses and Rapid Releasing Hooks

The Eckliff Circulator Company, Detroit, Mich., has placed on the market a new line of equipment for handling lifeboats on board ship. The object sought is to secure safe and speedy raising, lowering and releasing of lifeboats. The apparatus is so constructed that the lowering mechanism can be controlled by one line in the hands of one man. One



J-H Windlass Mounted on Davit

windlass, which can be bolted to the deck or to the davit, will handle each lifeboat. Steel cables only are used.

In numerous demonstrations a twenty-six-person lifeboat has been swung out and lowered to the water, a distance of 38 feet, with the J-H windlass by two men in twenty seconds. As a matter of fact, one man can control the lowering of the boat, and should he be disabled and drop the controlling line no harm will result, as an automatic governor positively prevents a too-rapid fall.

The releasing hook is so constructed that when the hook is closed the tumbler engages an upper cross arm of the frame in such a manner as to securely lock the hook in the closed position. It is claimed that it is impossible for these interlocking parts to become disengaged until the releasing lever is lowered from the upright position. Instant and simultaneous release of the hooks at both ends of the boat is accomplished by means of a releasing mechanism from which a cable runs to the lever of each hook. Tension is applied to both cables simultaneously, so that both hooks open at the same instant.

Bonus for Galveston Shipbuilders

The Galveston Commercial Association is endeavoring to raise a fund of $100,000 with which to pay bonuses of 2 percent to shipbuilding companies for each ship built at Galveston costing not less than $300,000.

Twenty-Thousand-Ton Floating Dry Dock Being Installed at Sparrows Point

The Bethlehem Steel Corporation is installing at its Maryland shipbuilding plant, Sparrows Point, Md. (formerly Marine Department, Maryland Steel Company), a floating dry dock of 20,000 tons lifting capacity, designed by William T. Donnelly, naval architect and consulting engineer, New York.

The pontoons of the dock are of wood, and contain 4,000,000 feet of yellow pine. The side walls or wings are of steel, 3,000 tons of steel being required for their construction.

Shipping Valued at $8,000,000 Will Be Built in Maine

The Maine Shipbuilding Committee, appointed several months ago by Governor Milliken, to arrange for the construction of wooden ships in Maine as a part of the national shipbuilding programme, announced on August 10 that shipping valued at $8,000,000 will be built in Maine. Each of the vessels will cost about $300,000 without machinery. Ships valued at $1,500,000 are already under construction in various Maine shipyards.

All Merchant Ships to Be Armed by the Government

That the Government intends to push the work of arming all merchant vessels was indicated by a recent announcement of an order given to the Wagner Electric Company, St. Louis, Mo., for the manufacture of 1,000 4-inch guns to cost $6,000,000. These guns will be used solely, it is understood, for arming merchant vessels and army transports.

Five-Thousand-Ton Concrete Ship Now Being Built in San Francisco

The San Francisco Shipbuilding Company, through McDonald & Kahn, concrete contractors, designers and builders, and Calvery & Garden, consulting marine engineers, are building a concrete ship 320 feet long, 44 feet beam and 32 feet deep, of 5,000 tons, on San Francisco Bay. The estimated cost of the vessel is $350,000. Before the propelling machinery is installed the hull will be towed to Seattle in order to test its strength at sea.

National Shipbuilders' Association Formed

The National Shipbuilders' Association was organized in Washington on August 11, as a result of an extended discussion among representatives of private shipbuilding companies as to the means whereby the interests of the several companies as well as the interests of the Government could be best fostered.

It is believed that the association will not only save time to the shipbuilders, but that it will also obviate the necessity of unnecessarily utilizing the valuable time of the members of the Shipping Board. It will insure closer touch with the Shipping Board and Emergency Fleet Corporation by having innumerable questions, which are bound to arise, handled collectively rather than individually.

No fees will be charged to the members of the association, and the assessments will be confined to the actual expenses for the maintenance of the association's headquarters in Washington.

Naval Training Schools

A training school at Newport, R. I., to fit members of the Naval Reserve for commissions in the Navy, will be opened by the Navy Department at the Cloyne school house. A course of four months will be given.

Through the Division of Naval Militia Affairs the Navy Department has approved of another Federal training station for the naval militiamen to be located at Rochester, N. Y. This station occupies the armory of the Third Battalion, located on Lake Ontario.

The North Carolina Shipbuilding Company at Morehead City, capitalized at $200,000, under the laws of North Carolina, has received a contract for two vessels from the United States Shipping Board.

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Pacific Coast Port Authorities to Hold Convention

The Pacific Coast Association of Port Authorities will hold its annual meeting at Portland, Ore., September 4, 5 and 6. Charles B. Moores, Portland, chairman of the Commission of Public Docks, is president, and G. B. Hegardt, engineer for the Portland Commission, is secretary.

American Shipbuilding Company's Profits Increase

The annual report of the American Shipbuilding Company, Cleveland, Ohio, shows net profits for the fiscal year ended June 30, 1917, of $3,148,040, after deducting $400,000 from net earnings for an estimated six months' excess profits tax. This is equal to $34 a share on the common stock after allowing 7 percent for the preferred.

Shipbuilding Contracts

The J. H. Mendell Engineering Company, Manchester, N. H., has received a contract for the construction of thirty wooden ships from the United States Shipping Board. This company will build a large shipyard on the Piscataqua River at Newington, near Portsmouth, N. H. Over 3,000 men will be employed at this yard.

A new shipbuilding company, which is reported to have orders for twelve steel steamships with a capacity of 9,500 tons each, will be located at Brunswick, Ga.

A shipbuilding concern, of which Charles Bright, South American railroad builder, is the head, has acquired waterfront rights at Sandusky, Ohio, for a large shipbuilding plant. The company, it is announced, has a contract for building $5,000,000 worth of small boats for the Government.

Chester Shipbuilding Company Reorganized

A reorganization of the Chester Shipbuilding Company, Inc., Philadelphia, has been announced. Hereafter the Chester Shipbuilding Company will control only the shipbuilding plant at Chester, Pa., and the plant recently acquired at Bristol, Pa., will be under the control of the Merchants' Shipbuilding Corporation, which was recently incorporated by Arthur P. McKinstry, a lawyer, 60 Wall street. Officers for the Merchants' Shipbuilding Corporation and the Chester Shipbuilding Company are the same, and have elected as follows: Chairman of the board of directors, W. A. Harriman; president, R. H. M. Robinson; vice-president and comptroller, C. B. Seger, all of 165 Broadway, New York; vice-president, Carl W. Hamilton; secretary and treasurer, William M. Simpson, both of 50 Broad street, New York; general manager, W. T. Smith; consulting engineer, C. P. M. Jack; engineering manager, Max Willemstyn, all of Finance building, Philadelphia.

The Merchants' Shipbuilding Corporation has obtained a contract from the Emergency Fleet Corporation to build twenty or more steel cargo-carrying steamers. The Chester Shipbuilding Company is reported to have received a similar contract.

Noted Naval Architect Dies

Washington Irving Babcock, head of the firm of Babcock & Penton, naval architects, New York, and son of the late Capt. David S. Babcock, died at his home in New York on August 7, aged 59.

Mr. Babcock was one of the best known naval architects in the United States, having been associated for years with prominent developments in shipbuilding on the Great Lakes and the Atlantic coast. His father, Capt. David S. Babcock, was president of the Providence & Stonington Steamship Company, and his son, who had been educated at the Rensselaer Polytechnic Institute, Troy, N. Y., and served his apprenticeship with John Roach & Son, Chester, Pa., and at the Morgan Iron Works, New York, was appointed assistant to the president of the Providence & Stonington Steamship Company at the time of his father's death.

In 1887 Mr. Babcock became manager of the Union Dry Dock Company, Buffalo, N. Y., and two years later he organized the Chicago Shipbuilding Company, of which he became general manager and vice-president and later on president. For years this yard was the most important shipbuilding plant on the Great Lakes. Finally, in 1889, it was absorbed by the American Shipbuilding Company, after which Mr. Babcock became established in New York as a consulting engineer and naval architect.

W. I. Babcock

In 1907, H. Penton, naval architect, Cleveland, Ohio, became associated with Mr. Babcock, under the firm name of Babcock & Penton. Mr. Penton had formerly been associated with Mr. Babcock as chief engineer of the Chicago Shipbuilding Company, and later as chief engineer of the Great Lakes Engineering Works. The firm will be continued under its present name.

Mr. Babcock was a vice-president and member of council of the Society of Naval Architects and Marine Engineers, and also a member of the American Society of Naval Engineers, Institution of Naval Architects (Great Britain), and a member of the Engineers' Club, New York. Mr. Babcock was a pioneer in several lines of development in shipbuilding, especially on the Great Lakes. He was an early advocate on the lakes of the modern type of bulk freighter. He designed and built the first 400-foot lake bulk freighters, and was also the designer of the first electrically-propelled and controlled boats, these being the Chicago fire boats. The firm of Babcock & Penton was also responsible for the development of the self-unloading type of ship which is now extensively used on the Great Lakes.

Personal

CHARLES L. REED, formerly with the Maryland shipyard of the Bethlehem Steel Corporation, has taken charge of all the steel work at the Todd yards, Tacoma, Wash., as superintendent of hull construction.

M. A. NEELAND has been elected president of the New York Shipbuilding Corporation, Camden, N. J., succeeding S. M. Knox, who has been elected chairman of the board of directors. George J. Baldwin, former chairman of the board, has been elected chairman of the executive committee, which has been increased from three to five members.

A. E. MARTELL, formerly chief engineer of the oil engine department of the Southwark Foundry & Machine Company, Philadelphia, Pa., builders of the Southwark-Harris Diesel type oil engine, is now associated with Leonard B. Harris, consulting engineer and naval architect and inventor of the Southwark-Harris oil engine, with offices at 411 Walnut street, Philadelphia.

S. CULYER JENKINS has recently been appointed assistant general manager of the Slidell Shipbuilding Company, Inc., Slidell, La. Mr. Jenkins was connected with the Newport News Shipbuilding & Dry Dock Company, Newport News, Va., for a number of years, and was later appointed marine designer of the Panama Canal.

RAYMOND E. LOVEKIN, managing director of the American Screw Propeller Company, Philadelphia, Pa., recently returned from an extended visit to the shipyards on the Pacific Coast, where he was successful in securing large contracts from the principal shipbuilders and shipowners on the Coast.

E. C. BENNETT, formerly naval architect of the Fore River Shipbuilding Corporation, Quincy, Mass., has been appointed vice-president and general manager of the Newburgh Shipyards, Inc., Newburgh, N. Y.

W. H. BENSON has been appointed superintendent of hull construction of the Fore River Shipbuilding Corporation, Quincy, Mass.

WILLIAM J. DEED, of Boston, Mass., naval architect and power boat specialist, has been appointed consulting naval architect in the shipbuilding department of the American Shipping & Export Company, 112 Water street, Boston. This company recently purchased the shipyard of Thomas M. Fairchough & Company at Winthrop, Mass., and have under construction there, from Mr. Deed's designs and under his supervision, a fast patrol boat for John G. Quinby, Jr., of New York, which will go into naval service upon completion. The company is also negotiating for the purchase of other shipyards.

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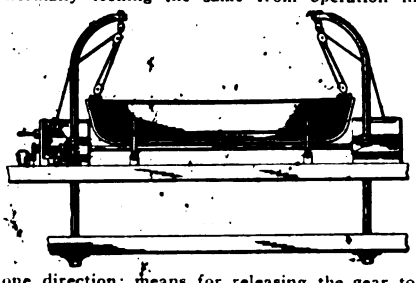
SELECTED MARINE PATENTS

The publication in this column of a patent specification does not necessarily imply editorial commendation.

American patents, compiled by Delbert H. Decker, Esq., registered patent attorney, Millerton, N. Y.

1,202,525. LAUNCHING APPARATUS. CHARLES HUNT, OF NEW YORK, N. Y.

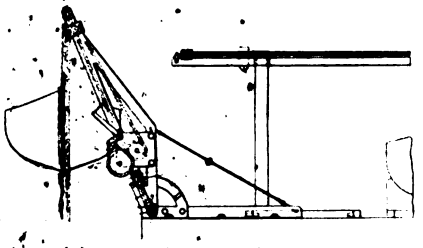
Claim 1.—A launching mechanism for boats having, in combination, davits and launching tackle for swinging the boat; a launching mechanism operatively connected to each davit includinug a train of gearing; and means for normally locking the same from operation in



one direction; means for releasing the gear to permit turning of the davits; means for breaking the train of gearing and simultaneously locking the same from turning; and means for controlling the boat while the same is being lowered. Eleven claims.

1,202,526. APPARATUS FOR LAUNCHING LIFE BOATS. ROBERT HUNTINGTON, OF MEDFORD, MASS.

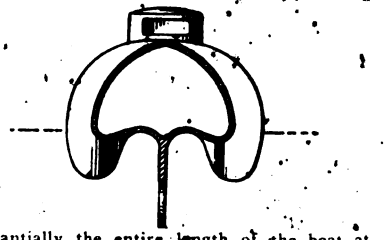
Claim 2.—In a device the combination with a vessel of two davits each presenting a forked lower end which is hinged to the vessel, a segmental gear fixed to the deck of the vessel and



situated between the arms of the fork of each davit, a gear journaled in the fork end of each davit and meshing with its segmental gear, means connecting said gears whereby both may be rotated in unison from a single point, thereby to swing both davits simultaneously inboard and outboard, and endless chain falls sustained by the davits. Five claims.

1,202,713. BOAT. EDWARD E. HEDGES, OF WELLESLEY HILLS, MASS., ASSIGNOR TO AMERICAN SUBMARINE BOAT DESTROYER COMPANY, A CORPORATION OF MAINE.

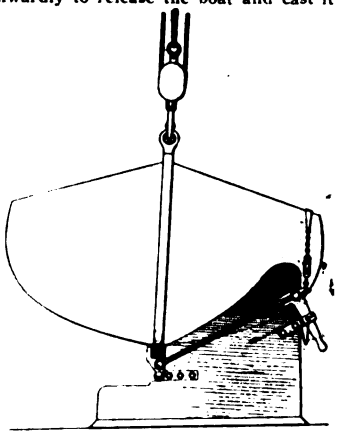
Claim 1.—A boat having drop bilges extending longitudinally thereof and a keel intermediate said bilges to form channels, extending



substantially the entire length of the boat at the water line, said keel extending a material distance below said bilges throughout the length thereof and to the upper margin of said channels, said upper margin being designed to be substantially in a plane coincident with the surface of the water. Five claims.

1,202,998. CHOCK FOR LIFE AND OTHER BOATS. AMOS S. HEBBLE, OF EAST ORANGE, N. J.

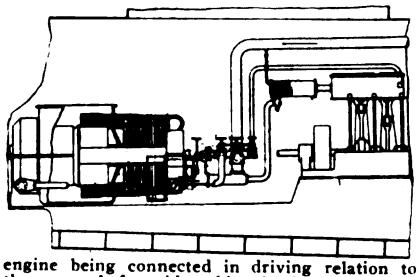
Claim 1.—A chock for boats comprising a rigid body secured to the deck of a boat and having an outboard surface to engage the boat at the inner side of the keel thereof, a member at the lower end of said body pivoted thereto and having a surface upon which the keel may rest and a jaw to extend along the outer side of said keel, an angular lever pivotally secured at the end of one arm thereof to the upper portion of said body and having its other arm exposed to serve as a handle for manual operation, a rod extending from the angle portion of said lever to said pivoted member of the chock, for turning said member outwardly and downwardly to release the boat and cast it out-



wardly from said body and throw its weight upon the cables and davits, and means for locking said lever in its restrained position holding said pivoted member against the said keel and in position to support the same. Six claims.

1,214,207. STEAM PROPULSION APPARATUS. JOHN F. METTEN, OF PHILADELPHIA, PA., ASSIGNOR TO THE WILLIAM CRAMP & SONS SHIP & ENGINE BUILDING COMPANY, A CORPORATION OF PENNSYLVANIA.

Claim 1.—The combination with a reciprocating engine, of a turbine, said turbine and

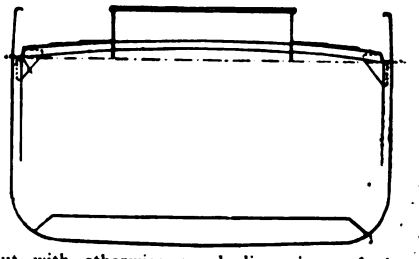


engine being connected in driving relation to the same shaft, said turbine having full power stages and auxiliary stages, means for supplying steam to said engine, and means for passing steam from the exhaust of said engine to the turbine and admitting it to either the full power or auxiliary stages. Thirteen claims.

British patents compiled by G. F. Redfern & Co., chartered patent agents and engineers, 15 South street, Finsbury, E. C., and 10 Gray's Inn place, W. C., London.

105,315. "IMPROVEMENTS IN DECKS FOR SHIPS." PER BJORN-ROLI, MECHANICAL ENGINEER, OF KIRKEGATAN 8, CHRISTIANIA, NORWAY.

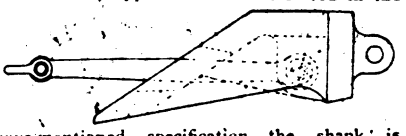
This invention has for its object such an arrangement as will secure a large cubic tonnage, greater draft and greater carrying capacity than that obtained with a normal deck,



but with otherwise equal dimensions of the hull. For this purpose the stringer plate is flanged (bent up) at the inner edge of the frame and above the beam, the height of which is increased and laid above the molded line instead of below the same. This arrangement may be used for the whole length of the ships or for part of the same, for instance, the well-deck of well-deck ships. By means of this arrangement the height of hold is augmented by the height of the beam, as compared with the hold of a normal ship.

105,183. "IMPROVEMENTS IN ANCHORS." J. B. RICHARDSON, OF MAESYFFYNNON, PONTYPRIDD, IN THE COUNTY OF GLAMORGAN, MANAGING DIRECTOR OF BROWN, LENOX & CO., LTD., OF PONTYPRIDD.

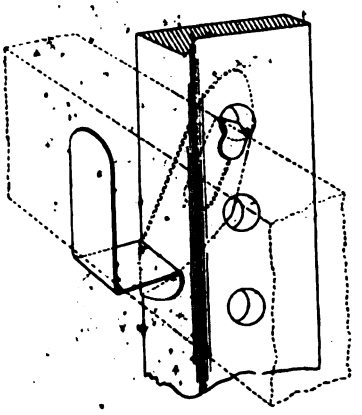
This invention relates to anchors of the type described in the specification No. 18,867, of 1901. In the type of anchor described in the



above-mentioned specification the shank is pivoted by means of a pin which passes through holes in two lugs carried by the anchor block. According to this invention, the lugs and webs are so placed that they take the pull of the shank in compression when the shank is in tension. Preferably, the webs extend to the top wall of the block.

103,954/16. "IMPROVEMENTS IN OR RELATING TO CLEATS OR BRACKETS FOR SHIPS' CARGO AND OTHER BATTENS, AND THE LIKE." D. J. GREEN, OF 61, QUEEN ALEXANDRA ROAD, NORTH SHIELDS, IN THE COUNTY OF NORTHUMBERLAND, SHIP DRAUGHTSMAN.

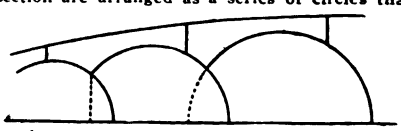
In this cleat or bracket the arm which lies edgewise relative to the arm that is bent to form a holder for the battens, has three sides



of a rectangle punched in it, or has a longitudinal slit, and the tongue thus formed bent laterally and downwardly to form an attacking hook, while the upper part of the said arm extends beyond the hook and is adapted to bear against one side of the rib, or support the depending part of the attaching hook bearing against the opposite side of the rib.

16,834/15. "IMPROVEMENTS IN THE CONSTRUCTION OF TANK VESSELS." J. W. ISHERWOOD, OF RAGGLESWOOD, CHISLEHURST, NAVAL ARCHITECT, AND J. W. STEWART, OF 21, HOLMWOOD GARDENS, CHURCH END, FINCHLEY, N., NAVAL ARCHITECT.

This invention relates to improvements in the construction of tank vessels for carrying oil and other liquids in bulk. In vessels constructed in accordance with this invention the tanks of circular or approximately so cross-section are arranged as a series of circles that



overlap or encroach upon each other in plan, or in other words, a portion of the wall of each tank is omitted, as seen in plan, to permit a portion of the wall of the adjoining tank to encroach on its interior, the tanks being efficiently attached to each other so as collectively to increase the longitudinal strength of the vessel.

105,189. "A SLIDING WATERPROOF HATCH FOR FREIGHT CARRYING CRAFT." H. FISHER, 6, WILSON STREET, PLAISTOW, ESSEX, WHARF FOREMAN.

The invention relates to improvements in flexible hatchways of the kind composed of thin connected metal plates adapted to be coiled upon drums, and adapted to be fitted to all freight-carrying craft as lighters, barges and canal-boats. The object is to provide a simple arrangement for maintaining such hatches in the position to which they have been opened by hand, and for draining the hatch coamings of all water or rain.

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